FLIGHT and The AIRCRAFT ENGINEER

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The Outlook

"It Makes You Think"

DURING the process of aircraft evolution the search for better and still better performance has resulted in refinements being forced upon the designer which were unnecessary in the old biplane days when retractable undercarriages and variable-pitch airscrews were not. These refinements have undoubtedly contributed to the efficiency of aircraft, but they have brought with them the need for instruments and indicators which have, in the course of time, placed in front of the pilot a panorama of dials that appears downright terrifying to anyone confronted with them for the first time.

A contributor to this week's issue raises the question, "Are all these dials really unavoidable?" The answer to this time-worn question is incredibly difficult to give. "Kismet" argues mainly on the basis of weight of instruments, which may, he considers, be sufficient in some cases to prevent a damaged aircraft from reaching safety. We are not certain that this argument is a logical one. If a hundredweight of dials and gadgets was saved, some other item of equivalent weight would undoubtedly be installed, and this might well be of such a nature that, as in the case of the dials, it could not be jettisoned. In that case the crew would have been deprived of useful sources of information without benefiting in other ways.

Our contributor compares two fighter aircraft in a scrap, one with but four instruments and the other with full complement, and asks if the fully equipped pilot makes use of all his instruments during the fight. Obviously he does not, but the fact that he disregards them momentarily can hardly constitute a handicap. What "Kismet" does not appear to take fully into account is that the actual engagement forms but a very small percentage of the aircraft's time in the air. During the rest of the time the instruments are justifying their presence.

In long-range bombing the carrying of instruments appears even more unavoidable. It is not difficult to visualise the possibility that without them, or at any rate without the majority of them, a distant objective might not be within range if a reasonable fuel margin and a worth-while bomb load were to be carried.

Some time ago we referred to the question of de-icers and cable cutters. We suggested that only the pilots could express definite views on which of the two, if both could not be fitted, they would prefer to have. The same remark seems to apply with equal force to instruments. The answer is no easy one, and the concensus of views of practical pilots would be illuminating. We welcome the reopening of an important subject by "Kismet" because, in the words of the familiar broadcaster, "It makes you think."

Offensive Fighters

ONE unexpected result of the German occupation of France has been the conversion of the short-range fighter of the R.A.F. into an offensive weapon. Before May, 1940, it was possible to assert that the short-range fighter was the only purely defensive weapon in the world. It had not the tankage to carry it far into hostile country, and it could lift no really offensive bomb load. In fact, the term "interceptor" accurately described it. The long-range fighter

was always a weapon in a different class, and was obviously designed mainly for aggressive purposes.

The Germans used their single-engined Messerschmitts for an offensive purpose when they sent them as escorts to their day-bombers in the Battle of Britain, but in that case the bombers were intended to be the major weapons, the fighters acting merely as ancillaries. The daylight sweeps by the R.A.F. over Northern France have been different in character, for in them the fighters played the chief part. Sometimes they acted alone; at other times they were accompanied by comparatively small forces of bombers. The object always was to compel the Germans to withdraw their experienced fighters from the Russian front and so give definitely useful help to our Ally. In this our object was fully attained, for it has been calculated that before the end of the year about 50 per cent. of the fighter strength of the *Luftwaffe* had been concentrated in France. There were days when the British losses exceeded those of the enemy, but it is the total which matters. During the period of the most intense aggression by Fighter Command—that is to say, from the middle of June to the end of August—500 enemy aircraft were shot down by the fighters in our sweeps for a loss of only 250 of our own machines. These figures tell a very different story from the profit and loss account of the German aggression in the Battle of Britain, when the attackers had the heaviest losses. Our offensive has not been unduly expensive.

Unity of Command

IN 1918 Marshal Foch was appointed Generalissimo of all the land and air forces in France and Belgium after four years of divided command. In 1939 Lord Gort's B.E.F. was placed under the command of General Gamelin. Both these earlier attempts at unity of command have been overshadowed by the comprehensive step taken at Washington, which puts General Wavell in supreme command of all forces—sea, land and air—in the South-west Pacific. We believe that no step like this has ever been taken before. That a General Officer should command all the air forces in his area is, we believe, only common sense, but that he should have general control over naval forces too, in what is mainly a naval campaign, is unprecedented. Another anomaly, as some people will doubtless think it, is that the British naval forces in this area are to work under the orders of the American Admiral. The air interest in this unusual organisation is represented by an American Army officer as General Wavell's deputy—which shows that it is sometimes convenient to have an air arm in an army.

Hitherto the Japanese forces have been under a single direction, while the Allies have groped, so to speak, under separate British, American and Dutch Generals and Admirals. Now one master mind will control the whole strategy. This is the firstfruits of the Washington Conference.

THE BITER BIT: A Ju 87 dive-bomber, flown by an Italian pilot, which turned over on having to make a forced landing in our lines on the Western Desert. The main bomb is still in the ejector cradle which, at the moment of release, lowers the bomb to a point from which it can fall without hitting the airscrew. The manner in which the airscrew blades have broken shows the enormous strength developed by laminated wood.

War in the Air

THREE SERVICE CO-OPERATION : Bombs bursting on Herdla Airfield in Norway to render it temporarily unusable during the raid by our Army Commandos at Vaagso. Although the landing operation was a hundred miles away, this was the only airfield within striking distance.

Brilliant Sea, Air and Land Co-operation : The Russians in the Crimea : British Raid on Norwegian Islands : Japanese Air Superiority in the Pacific

THE closing days of 1941 saw two incidents in which naval, land and air forces co-operated to produce strikingly successful results. The more important of the two was the Russian landing in the Crimea, which resulted in the recapture of the towns of Kerch and Feodosia. The other was a much less ambitious effort, though also brilliantly successful, in which the Royal Navy, the Royal Air Force, and Commandos of the British Army worked together to raid two little islands off the coast of Norway, namely, Vaagso and Maaloy.

The Russian landing in the Crimea was an operation in which warships engaged the Germans' land defences while bombers flew overhead and helped to silence the opposition. Both had to contend with snowfalls and heavy rain, but both accomplished their tasks. Under cover of this double bombardment the Russian infantry landed and captured the enemy's lines. The strength of the forces which the Russians put ashore has not been stated, but if they are sufficient (and they are being reinforced) they will threaten the Germans who are investing Sevastopol. The enemy was obviously taken by surprise by this daring exploit. In many ways it recalls the enterprise by which British forces recaptured Berbera in Somaliland, and we may be sure that the Russian staff has studied all the operations on both sides in this war.

MIXTURE AS BEFORE : The disintegrating link belts of the 20 mm. cannons fitted to Spitfire Vs and Hurricane IIs are filled with a variety of ammunition. In the belts shown here, armour piercing, high explosive and incendiary tracer shells are all included in their proper proportions.

The British raid on the Norwegian islands took place on Saturday, December 27th. By comparison, it was only a small affair, but the combined work of the three Services was as perfect as it well could be. As the naval vessels entered the channel to the south of Vaagso before daylight, Hampden bombers put down a smoke screen to cover the landing of the Army Commandos. A fighter escort of Blenheims and Beaufighters of Coastal Command was provided, and each fighter sortie was relieved at the end of its period of duty and flew the 300 miles home with a margin of fuel. Blenheims attacked the nearest airfield, bombed the wooden runways

WAR IN THE AIR

and prevented the enemy machines from taking off. A couple of Messerschmitts succeeded in getting to grips with our aircraft and shot down two of them. Four Heinkel 111s were shot down. Our aircraft also silenced some of the enemy batteries, and one flight of Blenheims found a convoy off the coast and sank one ship for certain. The warships destroyed a number of other enemy vessels.

The Germans describe this raid as having only a nuisance value. It is more probable that it was a dress rehearsal for greater operations by all three Services in conjunction. Combined operations of this sort may well develop into something really big in the future.

Victorious Russia

ON the Moscow front the Germans have suffered a heavy defeat. They are not routed, but they are in retreat over country which offers no hopeful line of resistance, suffering terribly from the cold, and outnumbered in the air. Troops were brought up from Cracow, it is said, by air in a vain attempt to stem the Russian advance. It is reckoned that up to 50 per cent. of their fighter strength has been withdrawn to France to meet the British sweeps, while of late they have been massing bombers in Greece, Crete and Sicily, no doubt hoping to check General Auchinleck's advance before the whole of Italian Libya is lost and the British forces advance up to the boundaries of French Tunisia. No wonder that Hitler's New Year message to the German people was pitched in a minor key and contained something like a prayer that Germany might be saved in the coming year.

Stiff fighting has continued round Jedabya, where General Rommel has lost more of his remaining tanks. The losses of the Axis air forces are amazing, and airfields have been falling into the hands of our troops on a wholesale scale. One very striking incident was a raid by a regiment of Sikhs on Derna airfield, which overcame all resistance and did immense damage. General Auchinleck has been assaulting Bardia, and as the enemy garrison has no hope of relief the place must fall—perhaps it will have fallen by the time these words are published. The use of this port will simplify our supply problems, which have been growing as our forward troops get farther away from their base. Benghazi is in our hands, but the port has been much damaged. At the same time, Middle East bombers have been raiding air bases in Greece and Crete. Damage has been done at the Piræus and Heraklion, and the submarine base at Salamis has also been bombed. The shade of that brilliant scamp Themistocles must have rejoiced at this last-mentioned effort by the friends of Hellenic freedom. Tripoli and places on either side of it are, of course, regularly visited by our bombers.

IDENTIFICATION PROBLEM : British troops searching the remains of an enemy bomber shot down in Libya. Souvenirs will be collected and cherished only to be thrown away on the first full-pack march.

In the Pacific

IN the meantime things have been less cheerful in the Pacific. Japanese bombers have raided Rangoon, but lost a high proportion of their number to Allied fighters. The American volunteers who have undertaken to guard the Burma road helped the British fighters. There have been alerts at Singapore, but the place has not been knocked about so far. The R.A.F. bombers have responded by

ENEMY AIR LOSSES TO JAN. 3rd.

	Over G.B.	Over Continent	Middle East
Dec. 28	0	0	3
,, 29	3	0	2
,, 30	0	8	4
,, 31	0	0	0
Jan. 1	0	0	5
,, 2	0	3	0
,, 3	0	0	2
	—	—	—
	3	11 On ground	16 428

Totals: North, 5,606; Middle East, over 3,362.

raiding the airfield at Sungei Patani, which is in Japanese hands. A report from the Netherlands East Indies says that an Australian squadron of Hudsons stationed in their islands bombed a Japanese cruiser off Celebes and set it on fire. The Dutch assert that the Japanese will get no oil from the wells in Borneo. The British force in Sarawak has withdrawn to the Dutch part of that island.

The New Pacific Command

WHILE the Japanese fleet dominates the Pacific for the time being and permits reinforcements to be landed in the Philippines, and presumably in French Indo-China, whence they march against Malaya and Burma; while attempted landings are made on the Malay peninsula and have to be repelled by British artillery, but not interfered with by the weakened British naval forces in that part, and while Japanese dive-bombers harass the American and Filipino forces in Luzon as they grimly fight on against ever-increasing hordes of Japanese troops, a step has been taken in Washington which may, and ought to, bring about a timely reversal of the tide of Japanese successes.

The Pacific campaign is primarily a sea-air affair. Japanese aircraft have crippled the British naval forces at the key point of Singapore, and have done considerable damage to the American Pacific Fleet at Pearl Harbour. It is these preliminary steps which have allowed the enemy aircraft carriers to range far and wide over the Pacific Ocean, and have made possible the landing of Japanese troops on the various islands. Those troops have been accompanied by dive-bombers, which have played their regular part in the land fighting. All these successes are due to preponderant sea power, cleverly combined with the use of air power.

On the other hand, we may recall that President Roosevelt has stated that, despite the damage done at Pearl Harbour, the U.S. Pacific Fleet is still a well-balanced fleet. Some American warships are certainly in the Atlantic playing their part in the battle for the supply line between the Americas and the Old World. But, though official knowledge is not to be expected, we may assume that, while the R.A.F. can prevent the *Sharnhorst*, *Gneisenau* and *Prinz Eugen* from emerging from Brest, there is no reason why the American battleships should be in the Atlantic. Of the Pacific Fleet we have heard no news since Col. Knox returned from Hawaii. That is as it should be. It suggests that that fleet is busy, and when a fleet is busy it keeps silence. Of course, it may be waiting for reinforcements, British as well as American, but it may already have begun to search for the Japanese battle fleet. The American carriers must be very active in sending out scouting aircraft to search the vast ocean for that enemy fleet, but there are only certain areas where it is likely to be found. If the Japanese battle fleet can be smashed in a modern Trafalgar, which ought not to be beyond the combined powers of Britain and the United States, everything else would follow naturally and, so to speak, easily. Once the Japanese are deprived of the command of the seas —which depends on their battleships —the Allies will be able to deal with all their scattered landing parties, each of which would be cut off from its base.

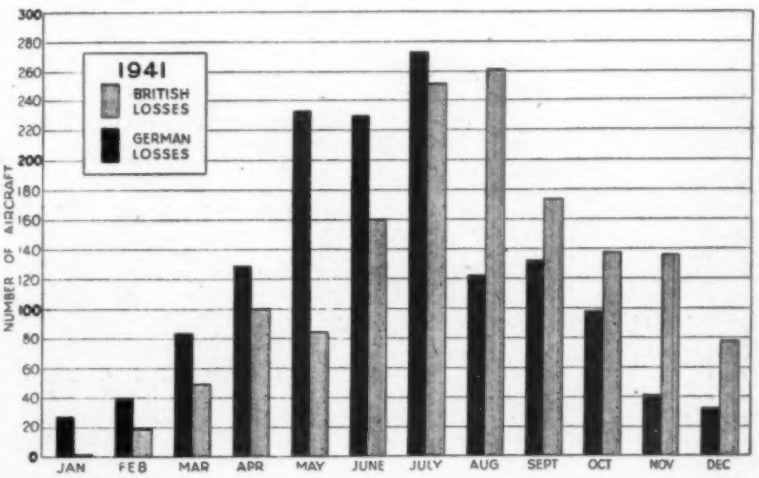
But, with so many Japanese expeditions in progress, so many local interests involved, unity of Allied command is needed as never before. On our side there are forces from Great Britain, Australia, New Zealand, the Netherlands East Indies and the United States, all fighting hard in or on all three elements. One co-ordinating mind, capable of thinking in terms of grand strategy, was obviously needed, and General Wavell has been chosen as that man. It may strike many as strange that a soldier should have been chosen to rule a campaign which is mainly naval and aerial in character; but the requisite in the supreme commander is not that he should be able to tell an Admiral how to deploy his ships for a fleet action, nor that he should be an authority on the siting of airfields and the combined use of bombers and fighters, but that he should be able to see the Pacific war as a whole and be able to combine his forces of many nations and three Services, and direct them to the best advantage. We British believe that no one could do that better than Gen. Wavell, and evidently President Roosevelt is of the same opinion.

BRITISH AIR LOSSES TO JAN 3rd.

	Over G.B. A'crft.	Over Continent B'bns.	Ftrs	Pilots	Middle East A'crft.
Dec. 28	0	7	0	0	1*
,, 29	0	0	1	1	1
,, 30	0	2	3	3	4*
,, 31	0	0	0	0	2
Jan. 1	0	0	0	0	2
,, 2	0	0	2	2	2
,, 3	0	1	0	0	2
	—	—	—	—	—
	0	10	6	6	14

Totals: North, 3,143; Middle East about 862. *1 Pilot safe.

Great things were expected of the meeting of the President with the British Prime Minister—who is himself a strategist on the grand scale—and this decision is the first outcome of the meeting. It is so bold, comprehensive, and unusual a step that it almost takes one's breath away. Without that meeting the Allies might have stumbled along for weary years of hard fighting and losses before they achieved unity of purpose and action. Soon, perhaps, Russian air strength will be added to the other forces arrayed against Japan. Meanwhile, the Russians press the Germans back all along the line. It has been suggested that the *Luftwffe* concentration in Greece and Crete was meant for use against the Crimea. If so, the Russian landing there has forestalled the move. The aircraft may now, perhaps, be diverted to Tripolitania.



The above diagram deals with British and German losses in the Northern Area of the war, including the episode of the R.A.F. Wing in Russia. It does not include the Middle East, or enemy aircraft shot down by ships and the Fleet Air Arm.

HERE AND THERE

Mosscraft Abroad

A MOSSCRAFT has been demonstrated at Toronto by Ronald Moss, who is one of the five brothers responsible for its design and construction. Two of the brothers are testing Lockheed aircraft in England.

Landing in U.S.A.

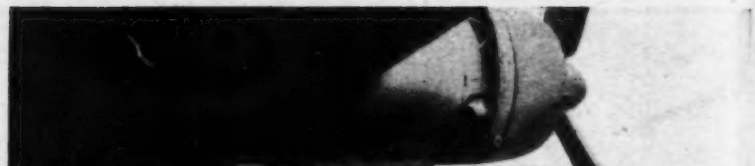
AT the close of the year the United States had a total of 2,412 airports and 365 seaplane bases in operation. Of the airports, 291 have paved runways, and 22 of the seaplane bases have night lighting equipment.

Bad Prophets

DURING a recent visit to Washington, Orville Wright said that in the early days of flying he and his brother Wilbur felt certain that aircraft would prove to be such a terrible weapon in warfare that human beings would refuse to endure the terrors it would provide. Hitler thought this—and he was wrong, too.

Eagles' Nest

TWO-THIRDS of the pilots of the American Eagle Squadrons in the R.A.F. received their *ab initio* training in the Civil Aeronautics Administration's programme. This corresponds to the Civil Air Guard which was in force in this country up to the outbreak of hostilities. Since its inception in 1930 the C.A.A. programme has trained more than 55,000 pilots.



MARTIAL FIRE: The 70-ton Martin Mars flying boat which was nearly destroyed by one of the starboard engines catching fire during tests. The airscrew blades were thrown off and punctured the hull aft of the pilot's cockpit. The offending motor finally dropped off into the water.

Warplanes in Canada

ACCORDING to Ralph P. Bell, Director-General of aircraft production in Canada, the Dominion will have 10,000 planes in the air for training and Dominion defence by the end of 1942. Repairing, maintaining and overhauling this number of planes will cost $100,000,000 annually. To date 8,200 aircraft are on order in Canada.

Astronautical News

AT an engine test meeting of the American Rocket Society a fuel-cooled design was demonstrated by Mr. J. A. Wild. The fuel charge consisted of a gallon of alcohol and 8 lb. of liquid air instead of the more usual liquid oxygen.

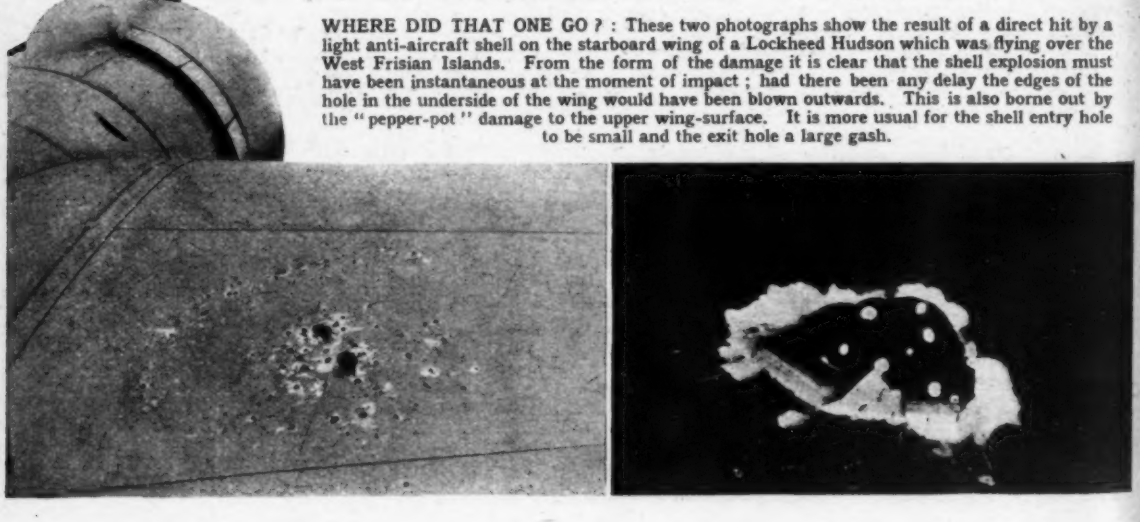
Ignition was by gunpowder fuse, and a thrust intensity of 80/85 lb. was maintained for some 25 seconds. Jet velocity was calculated at about 5,000 ft./sec.

Self-sealing Fuel Lines

THE Army and Navy air services of the United States are stated to have had already delivered over 500,000ft. of fuel piping made of self-sealing rubber. Complementary to the self-sealing tanks, the piping is reputed not to leak even after being hit by a bullet measuring half its diameter.

China Vanguards

OWING to a desperate need for some fast, high-altitude fighters by the Chinese air force, the R.A.F. have agreed to release for this purpose a number of Vultee Vanguards on order for Britain. The Vanguard is a low-wing monoplane credited with a speed of over 350 m.p.h. Its span is 36ft. and its length 28ft. Power is supplied by a 1,200 h.p. Pratt and Whitney radial. All-up weight is in the region of 6,000 lb.



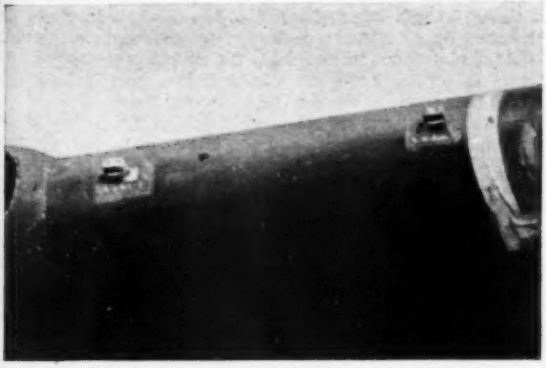
WHERE DID THAT ONE GO? : These two photographs show the result of a direct hit by a light anti-aircraft shell on the starboard wing of a Lockheed Hudson which was flying over the West Frisian Islands. From the form of the damage it is clear that the shell explosion must have been instantaneous at the moment of impact; had there been any delay the edges of the hole in the underside of the wing would have been blown outwards. This is also borne out by the "pepper-pot" damage to the upper wing-surface. It is more usual for the shell entry hole to be small and the exit hole a large gash.

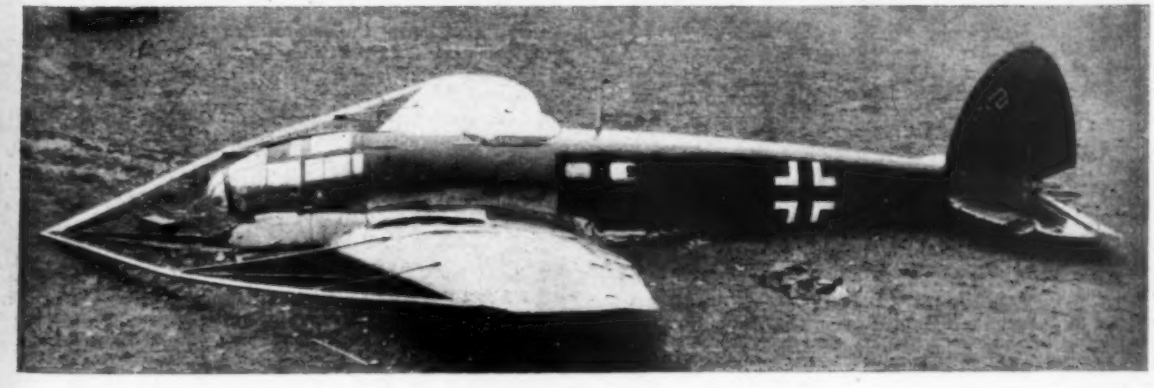
CABLE CUTTERS

Pictorial Comparison Between the British and German Methods

THE photographs on this page will come as somewhat of a shock to people of that tiresome section of the populace who wrongly imagine Germany has a monopoly where clever implements of war are concerned. In the two lower pictures is shown the cumbersome and hideous fend-off bar, weighing several hundreds of pounds, which the enemy is fitting to some of his Heinkel IIIs. What happens to the c.g. and bomb load with all this weight projecting in front can be guessed.

On the right is the Avro Manchester, on the leading edge of which can be discerned the neat cutters which we employ. In all there are eighteen of them. A close-up of two of the cutters is shown below. Apart from the difference in bulk and weight, the German device, it should be remembered, is only a fend-off, whereas that used by ourselves is a cable cutter. With either form of protection de-icing becomes a problem of no small magnitude.





WIRED FOR WARMTH

New Electrically Heated Flying Suit Perfected by G.E.C. in America : Mass Production to Start This Month

THERE has recently been awarded to the Bridgeport, Conn., plant of the General Electric Co. by the U.S. Army Air Corps, the first large contract for newly perfected electrically heated suits for high-altitude flying. These suits are a development based on knowledge gained during several years of experimentation and testing of the company's electric blankets, plus months of work in collaboration with Army technicians in developing and improving the flying suit. Factory space and equipment have been prepared for quantity production to begin in January of this year.

Materials Used

The perfected suit consists of an outer garment of wool fabric with wires sewn to the inside of the cloth, and an inner lining of cotton cloth. The wool, which is a good heat insulator and retards heat loss, is cut on the bias so that it will give freely together with the wires, which are sinuous and sewn on in parallel rows so that they give and retract with body movements. The 100 per cent. cotton lining permits heat radiation from the wires to the body.

Completing the new suit are a pair of boot inserts, or socks, made of wired olive-drab overcoating, and moulded rubber soles, which are worn inside standard light flying boots, and a pair of fine leather gloves wired on the back and at the wrists. The material and design of the gloves are those commonly used in ladies' dress gloves and give finger freedom and a delicate sense of touch essential for operation of instruments, camera adjustments, and shutter control and gun triggers.

The new G.E.C. electrically heated flying suit undergoing a test in a special refrigerating room. Boots and gloves are plugged into points on legs and sleeves. The temperature is controllable.

Four Circuits

Complete description of the final development is not released, but the original suit, which has undergone a number of improvements, had four electric circuits: two in the garment and one each for boots and gloves, which are plugged into outlets on the legs and sleeves of the suit. These circuits were connected to a switch box attached at the waist, by means of which heat could be switched on or off independently in suit, boots or gloves. A short pigtail connection from the switch box enabled the outfit to be connected to a control box mounted on the plane and connected with the plane batteries.

The first suit was an adaptation of the U.S. Army standard summer flying suit, and the improved outfit is many pounds lighter than the sheepskin-lined garments the new suits will replace. They are designed to keep airmen comfortable in air temperatures from +70 to −60 deg. F., as the amount of heat supplied is adjustable for temperature variations. Yet the whole suit will cost the Air Corps less than the old garment with sheepskin lining.

In designing the original suit the company sought the advice of airmen, arctic explorers, physicians and laboratory scientists, conducted exhaustive laboratory tests followed by flying tests by pilots at Wright Field and Patterson Field throughout last winter and by a bomber crew on a flight to Alaska. Laboratory researchers also studied an electrically heated uniform worn by a German airman who was shot down over England and found that so little heat was supplied that it provided almost no protection against cold.

Finding the Best Materials

Although the basic construction of the first General Electric suit was approved, the tests indicated the desirability of a number of improvements that have since been made. A particularly difficult part of the job was the finding of the best materials for all parts of the suit, as none must change its properties or deteriorate with temperature change from summer heat to sub-zero cold, and the raw materials must all be available in the United States. In the search for one item alone as many as 50 suppliers were queried.

Preliminary studies by Frank G. Manson, of the General Electric Co., led to the suggestion that, as the flying suit provided more heat than was needed to maintain comfort, the excess could be used to protect injured flyers from shock and chills that often develop into pneumonia. Also that the heating system could be adopted to electric blankets for use in ambulances. Therefore, to try out the plan, several ambulances for the British-American Ambulance Corps have been equipped with experimental automatic electric blankets.

ADVERTISED GOODS

THE fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

Twentieth of the Second Series

FRIEND or FOE?

A British and Italian Contrast : Miles Master II and Fiat G.50

The Miles Master II differs from its predecessor by having a Bristol radial in place of the vee Rolls-Royce engine. The disappearance of the radiator has made a big difference in the outline.

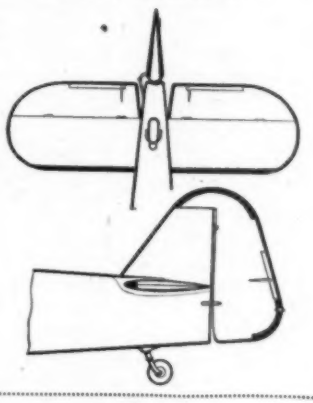
THE Miles Master II, which is a standard advanced trainer for R.A.F. fighter pilots, is, in its general appearance, not unlike the Fiat G.50, which is one of the standard fighters of the *Regia Aeronautica*. The resemblance, such as it is, lies chiefly in their radial engines and their cranked wings, but there could hardly be any chance of confusing their respective tail assemblies, and on this the spotter will mainly depend for identification.

In the first place, the vertical surfaces belong to two distinct types. Those of the Master adhere to the typically British principle in which the rudder is attached to both the fin and the extremity of the fuselage ; its lower edge lines up with the bottom line of the fuselage, and it projects well clear of the trailing-edge of the elevators. The rudder of the G.50, however, is attached solely to the fin and is thus set wholly above the fuselage tail, the pointed extremity of which projects slightly beyond its trailing-edge. This layout also finds considerable favour with American designers (especially on larger, multi-engined types), but it is, as a rule, only adopted by British designers when a single tail is combined with a rear gun-turret ; the Wellington is a good example of this. There are also exceptions, of course, such as the Skua and Roc.

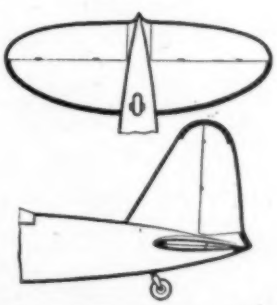
So far as outline goes, the chief characteristic of the Master's fin and rudder is its low aspect ratio. There is a generous slope to both leading- and trailing-edges, and the rounded apex is distinctly broad, as will be seen by the accompanying illustrations.

The tailplane of the Miles Master, however, has a fairly high aspect ratio. Its leading- and trailing-edges are both straight and parallel, and the tips are rounded with a varying radius that sharpens towards the front. The tailplane is mounted level with the base of the fin and the elevators do not encroach upon the arc swept by the rudder ; nevertheless, the inner edges of the elevators are sloped off slightly.

MILES MASTER II



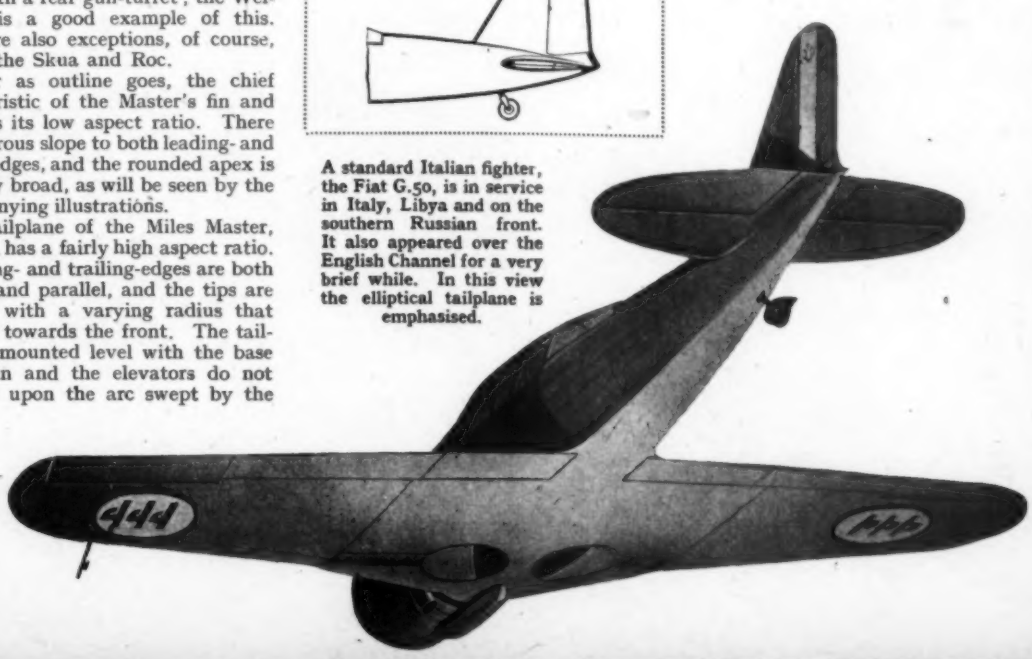
FIAT G.50



Turning now to the tail unit of the Italian machine, the vertical surfaces are of fairly high aspect ratio. There is a moderate slope to the straight leading-edge of the fin and, on the latest editions to go into service, the trailing-edge of the rudder is, to all intents and purposes, vertical. Some earlier editions of the G.50, however, show a slight inclination of the trailing-edge, though it is very doubtful if it is sufficient to be detected under normal spotting conditions. The apex of fin and rudder is evenly rounded and small compared with that of the Master.

The tailplane is elliptical in plan and is well back so that the trailing-edge is faired into the pointed extremity of the fuselage at the roots. By virtue of the rudder design and the setting of the tailplane below the base-line of the vertical surfaces, there is no need to cut away the inner corners of the elevators, and so no "bite" appears in the centre of the tailplane's trailing-edge when seen in plan.

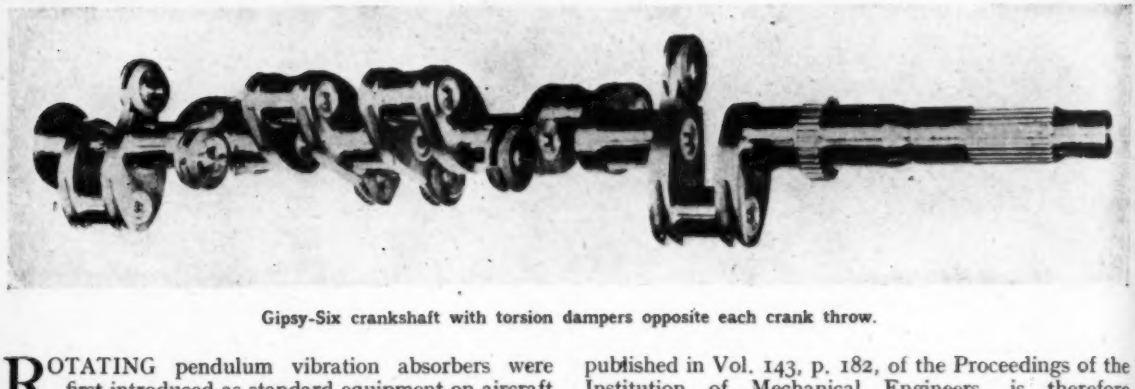
Next week : Ensign and Liberator.



A standard Italian fighter, the Fiat G.50, is in service in Italy, Libya and on the southern Russian front. It also appeared over the English Channel for a very brief while. In this view the elliptical tailplane is emphasised.

SHOCK DAMPERS

Some Interesting Results of Tests on a Gipsy Engine Crankshaft with Rotating Pendulum Torsional Vibration Absorbers



Gipsy-Six crankshaft with torsion dampers opposite each crank throw.

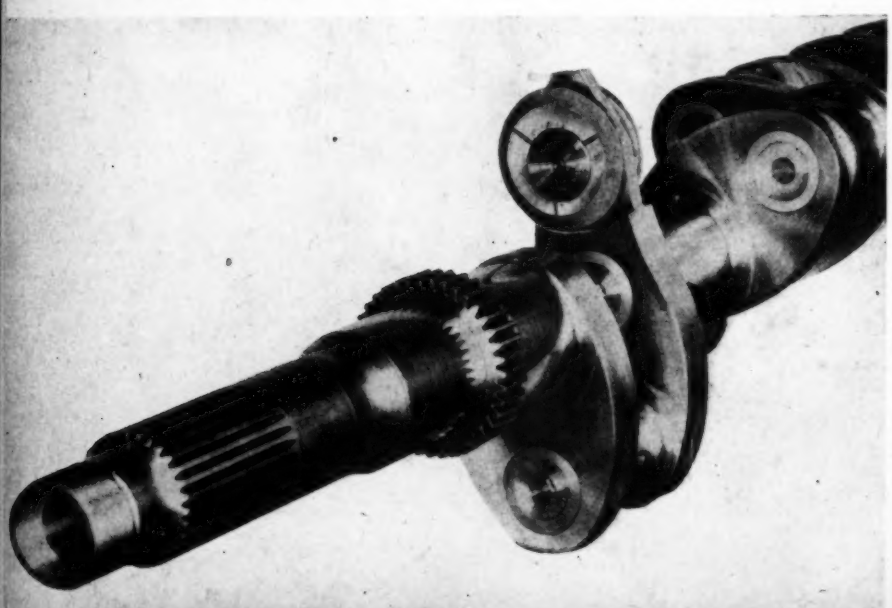
ROTATING pendulum vibration absorbers were first introduced as standard equipment on aircraft engine crankshafts in 1936, when one of the crankshaft counterweights on the Series "G" Wright Cyclone radial engine was used as a rotating pendulum vibration absorber. Service experience soon revealed that the device had succeeded in smoothing engine vibration to such an extent that quite important reductions of wear of engine components and of controllable-pitch airscrew mechanisms were being obtained. Indeed, the results were so encouraging that in the case of the G.100 Cyclone engine, introduced in 1939, both crankshaft counterweights were used as rotating pendulum torsional vibration absorbers, with the result that a higher take-off speed was found to be permissible and that even with this higher speed there was a reduction of airscrew stress due to reduced torsional vibration.

The Theory Explained

Until quite recent times the real principles underlying the operation of rotating pendulum torsional vibration absorbers were not generally understood, and there is little doubt that in many instances where these devices failed to give satisfaction the fault was due to an imperfect understanding of their mode of action. A paper entitled "The Elements of Pendulum Dampers," by R. W. Zdanowich and T. S. Wilson, published in Vol. 143, p. 182, of the Proceedings of the Institution of Mechanical Engineers, is therefore specially welcome at the present time when so much attention is being given to methods of increasing engine performance. This paper presents the subject in a particularly lucid and practical manner and is the first to be published in this country giving a really satisfactory theory of the rotating pendulum vibration absorber.

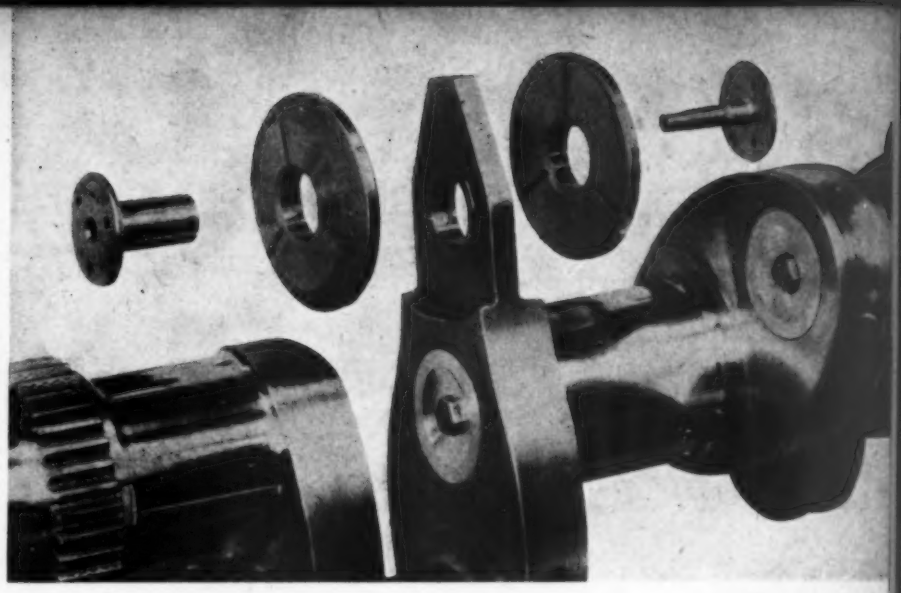
Practical Results

Amongst the communications on this paper published in Vol. 144, Proc.I.Mech.E., p. 223, is a description of some tests carried out by the De Havilland Aircraft Company on a Gipsy-Six engine crankshaft fitted with rotating pendulum absorbers. The arrangement of the crankshaft and the details of the absorbers are shown in the photographs. The absorbers are designed to reduce the Major 3rd order torque variation. There are six absorber assemblies carried on a corresponding number of crank webs and so arranged that an absorber mass is diametrically opposite each of the six crank pins. Thus the absorbers also function as crank web counterweights, giving a useful relief of main-bearing loading, which not only lightens the duty required from these bearings but also improves the internal balance of the forces acting on the crankshaft and crankcase. The latter consideration is of great importance from the point of view of crankcase design, since it enables lighter scantlings to be employed without the danger of fatigue cracks developing, at points of local stress concentration, due to the distortions which would otherwise be caused by the centrifugal forces originated by the rotation of the revolving parts of individual crank throws.



One of the shock dampers assembled . . .

Each absorber mass consists of two steel rings case-hardened and ground in the bores and on the side faces. These rings are quite free to roll on a case-hardened steel pin which itself is free to roll in a case-hardened steel bush pressed into a carrier arm forged integrally with the crank web. The special feature



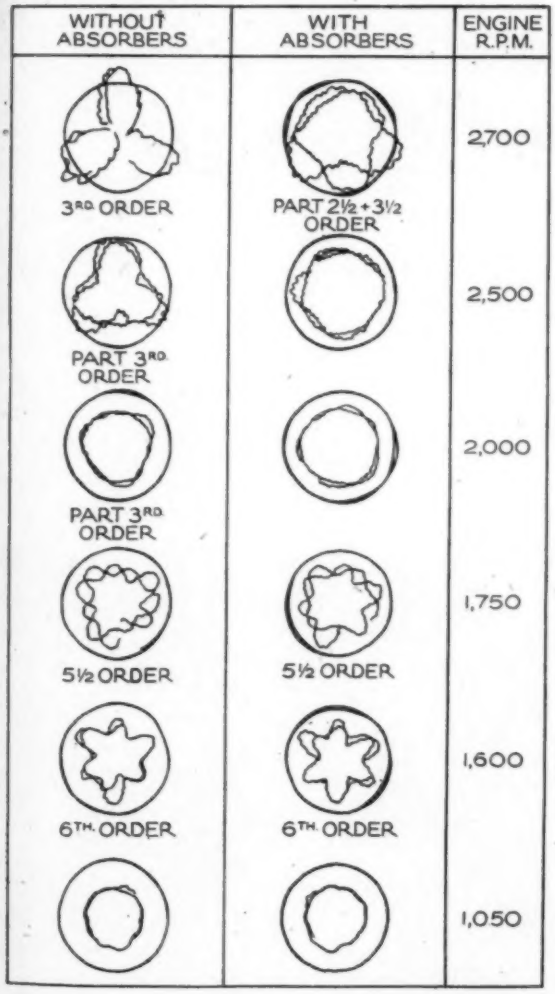
. . . and the same dismantled to show its few and simple parts.

of this method of suspending the absorber mass, which is based on Salomon's "Duplex Suspension" patents, is that the motion of the absorber mass, under the action of vibratory torques transmitted from the crankshaft, is the same as the motion of a simple pendulum.

The absorber rings are retained in place by flanges on the pin and locking bolt, the latter being secured by riveting over the end of the bolt after it has been screwed into position.

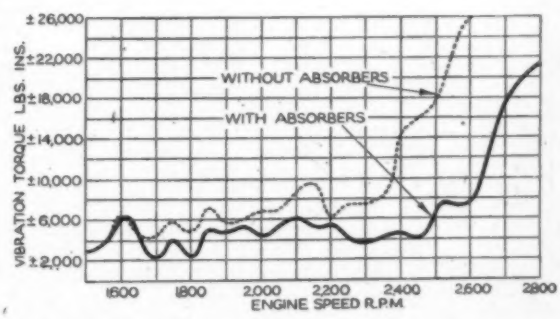
The tuning characteristics of the oscillating system were determined in accordance with the method described in the paper previously mentioned,* and the theoretical predictions were fully confirmed by subsequent tests. The illustration shows a series of records obtained from this engine by means of the R.A.E. recording torsion meter. This instrument records the amount of twist across a prescribed length of shaft at the power end of the engine. In the case of steady torques the record is a circle, of radius proportional to the transmitted torque, but if the shaft is being subjected to important torsional vibration stresses, the circular trace becomes distorted into a pattern representing the combined effect of the mean transmitted torque and the superimposed vibratory torque. At speeds near a resonant zone of torsional vibration, this distortion is very severe, and the circular trace breaks down into a lobed pattern in which, generally speaking, the number of lobes represents the number of vibratory impulses acting on the shaft during each revolution. Since the torsional stress in a given length of plain shaft is proportional to the twist over that length, these records also represent shaft stresses to some scale determined by the dimensions of the shaft and the calibration constant of the instrument.

* See also W. Ker Wilson, "Practical Solution of Torsional Vibration Problems." Chapman and Hall, London.) Vol. 2, Second Edition, 1941.



Interpreting the Records

The torsion meter record shows a large 3rd-order torque variation at 2,700 r.p.m. in the case of the engine without the absorbers. Traces of this 3rd-order variation are still discernible at 2,000 r.p.m. With the absorbers in action the 3rd-order disturbance is completely eliminated, although traces of the 2.5th and 3.5th orders are discernible at 2,700 r.p.m. The presence of these at 2,700 r.p.m. was predicted by the tuning calculations, and is, therefore, a useful confirmation of the theoretical treatment employed. Additional confirmation is afforded by the presence of the 5.5th and 6th orders at 1,750 and 1,600 r.p.m. respectively, both with and without the absorbers, since the tuning calculations indicated that the influence of the absorbers on these two orders would be negligible.



The illustration on the left shows diagrams obtained on the R.A.E. torsiograph with and without the shock dampers. On the right are curves showing typical variation of vibration torque with engine speed for a six-cyl., in-line engine. The curves were based on the torsiograph records.

SHOCK DAMPERS

The graph shows the torque variations at different speeds plotted from the torsion meter records for the engine with and without the absorbers. The very considerable reduction of vibration torque, and therefore of vibratory stress in the shaft and airscrew, over the whole of the flying speed range should be noted.

An outstanding advantage of the tuning methods adopted in this design compared with methods previously employed, which aimed at tuning the absorbers to exact resonance with the troublesome torque order, is that very close manufacturing tolerances on absorber details are not required. Thus, in the present example, satisfactory functioning is obtainable with a tolerance of ± 0.002in. on the pin diameter, in the bores of the bushings, in the crank web extensions, and in the absorber rings; and ± 0.008in. on the radial distance of the centre of the crank web extension bushing from the axis of the crankshaft. Furthermore, a series of supplementary tests proved that satisfactory operation would still be obtained with the pins and bushings worn to the extent of 0.005in. on diameter. It is unlikely, however, that wear of this amount would occur in normal service, since the parts are few and are of extremely simple design, whilst the oil mist inside the crankcase ensures adequate and efficient lubrication.

Even when there are no really severe resonance zones in the operating speed range of an engine, considerable benefit can still be obtained by fitting rotating pendulum vibration absorbers. For example, the use of pendulum absorbers to remove the principal torque impulses from in-line engine aggregates is tantamount to endowing the engine with a torque characteristic similar to that of an engine having twice as many cylinders. This is particularly advantageous in geared drives, where excessive torque fluctuation at the gear teeth might have serious consequences. The weight represented by an absorber scheme of the type shown in the photographs is from 2 to 3 per cent. of the engine weight. If, however, advantage is taken of the increased engine smoothness, resulting from reduction of torque fluctuations and internal bending forces, to use smaller scantlings for engine and airscrew components, it is probable that the total weight of an engine will be appreciably reduced when absorbers are fitted.

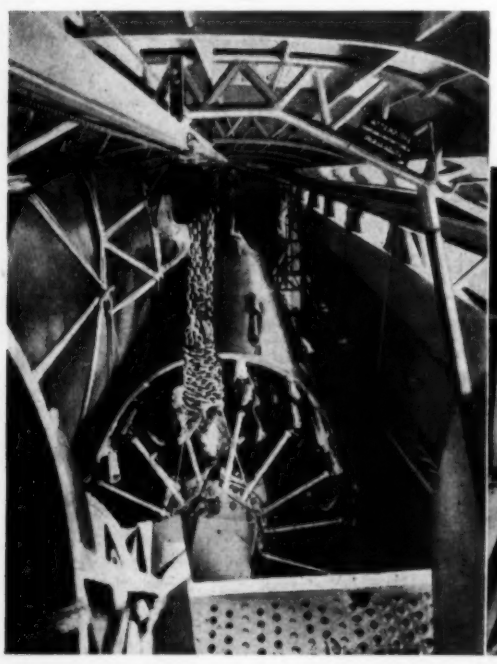
The results obtained from this De Havilland experiment are very encouraging, and now that satisfactory practical and theoretical studies appear to be becoming more generally available, there should be a considerable increase of interest in what is undoubtedly a powerful method of dealing with vibration troubles, especially taking into account the constructional simplicity of the device.

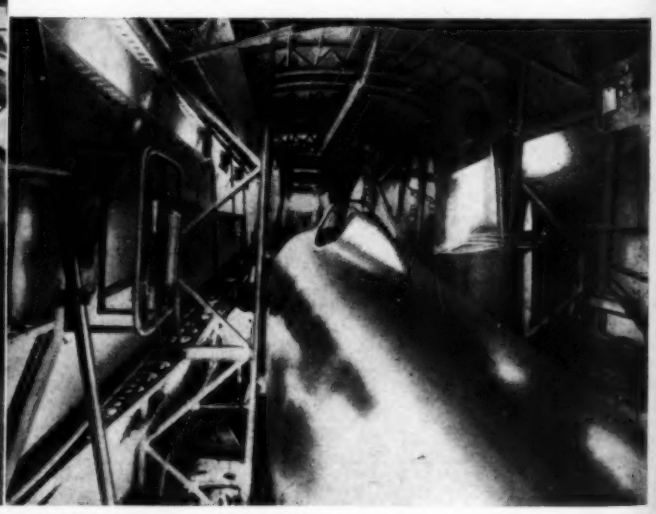
LITTLE FLEAS and LESSER FLEAS

Italian Service Carries Strange Cargo

THE carrying of aircraft engines by air is nearly as old as flying itself, but except for the Short-Mayo composite the carrying of aircraft on or in another aircraft has not hitherto been a commonplace. The war in the Mediterranean has brought into being a special Italian air service, known as the Servizi Aerei Speciali, which has carried many strange cargoes. It has been reported that during the first 100 days of its existence the service carried 635,000 lb. of material, 19,185 persons, and covered 1.5 million aircraft miles.

Perhaps the most interesting of all the cargoes carried was a Fiat C.R.42 single-seater fighter, which was transported inside a Savoia-Marchetti S.M.82. The Savoia is, of course, a large aircraft and the Fiat a small one, but nevertheless it is somewhat surprising that space could be found without dismantling the fighter into smaller components. It will be seen that there is room to stand the wing against the side of the cabin, while the fuselage, with its engine, rests on the floor.



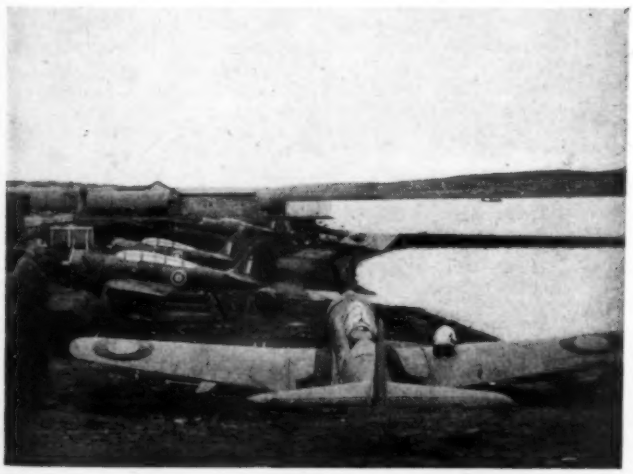


Solving the problem of transporting fighters to a scene of operations outside their range. A Fiat C.R.42 in the fuselage of a Savoia-Marchetti S.M.82.

NORWAY IN ICELAND

A Staunch Ally Flies with the R.A.F. in the Battle of the Atlantic

FLYING Northrop N.P.3 seaplanes, pilots of the Royal Norwegian Air Force are doing a great job of work in the northern latitudes. By virtue of their mode of life and training, the Norwegian pilots are eminently suitable for the patrol duties which are continuously carried out from Icelandic bases.



(Above) A group of Norwegian pilots outside their officers' mess. Although they operate under the command of the R.A.F., they are a separate unit, as is evidenced by the Norwegian flag on the mast.

(Above, left) The Norwegian Northrop N.P.3 seaplanes have flutings running the whole length of the underside of the float. These flutings tend to make the floats clean running on the water. Mr. Oswald Short had a flying boat hull built with somewhat similar flutings many years ago.

(Left) In this general view is shown the aircraft and slipways of the Royal Norwegian Air Force in Iceland. To prevent confusion, the machines carry the R.A.F. identification marks in addition to the small Norwegian flag painted on the fuselage.

(Bottom, left) Norwegian naval airmen at work on Browning guns in the armoury.

(Bottom, right) Airframe mechanics changing a Northrop float. Because these floats are carried on cantilever beams replacement is a comparatively simple operation.

Topics of the Day

ELECTRICS versus HYDRAULICS

The Problems of Accessory Power : "Indicator" Puts on a Mortar Board and Discusses Auxiliary Drives and Starting Methods

FOR one reason and another aircraft designers have always, it seems, been somewhat frightened of the introduction of too much "electricity" in a design. Partly because hydraulic power has tended to become universal, or nearly so, and is fairly well understood, and partly, perhaps, because some of the earlier "all-electric" layouts certainly gave a lot of trouble.

Yet, in theory, electric power should be far more reliable and far more easily understood. Outside the aircraft industry there are a great many more competent electrical engineers than there are hydraulic engineers, though inside this industry there are now people who understand nearly everything there is to be understood about the particular hydraulics which are applicable; consequently, hydraulic systems are just about as reliable as anything could be.

But are they so reliable in war conditions? Apart from fire risks, which should be easily combatable with fire-proof conduits and the like, enemy action is far less effective against "electrics." Whereas damage to a single pipeline in an hydraulic system will usually put the whole lot out of action, similar damage to an electric wire should not affect the rest of the system—and might not affect anything at all if a suitable duplication system is laid out.

For my sins I have, personally, a powerful bias in favour of hydraulics, but the other day, when I tried to justify this bias, I found it very difficult to do so. In the end, I had to admit that the bias is basically conservatism and the result of the normal feeling that hydraulics are something we really understand and are consequently to be relied upon. I don't really see that it is any easier to make a pipe or jack which will be reliable under high pressures than it is to make a wire and fuse which will be reliable under similar electrical "pressures."

Electric Reliability

As I've said, part of the trouble is that earlier attempts at "all-electric" layouts were not too successful. I can think of two pre-war commercial types which gave a lot of trouble. In one case the maintenance was probably too much for the ground crews, who had not had enough experience of the layout; the same type, when used in America, appeared to be satisfactory enough. In the other case the basic and original trouble was the result of faulty design, and failure was made all the more serious because, in the prototype, the final emergency system operated *through* the electric motor used for raising and lowering the undercarriage. Actually, neither of these aircraft in any way showed that the universal application of electrical power for auxiliary work was wrong in principle.

But its successful application *does* necessitate the use of really solid, reliable batteries capable of giving big outputs; ample charging facilities; and of superlatively designed and manufactured wiring systems. It is obviously no use having an all-electric layout if the power supply is inadequate and if, consequently, the whole system is going to fade out after, say, four engines have been started from the ship's batteries and before the engine generators can top up the system.

There must, furthermore, be a generator for each engine and a final emergency supply for use if the charging system fails and the main supply gives up. I have been in the air with an "all-electric" machine, no charge, and flat batteries. It was unpleasant, to say the least of it. Though it was possible to lower the undercarriage by the manual gear, the electrically operated airscrew was more or less stuck in one position, and I had no "full-fine" airscrew position for use if I had boobed on the approach. It should not be possible for a pilot to be in that sort of quandary.

Just now there is a tendency, at least in American types, for the systems to be mixed. There is one type, for instance, in which the hydraulic pump for the undercarriage and flaps is driven by an electric motor, with a hand pump for emergency operation, and another in which the same essential work is done by an hydraulic engine-driven pump, while auxiliary hydraulic power is provided by an electric motor! Very odd, but perhaps it is better, in the present stage of development, to work things more or less on those lines. Eventually, when we have really reliable bits of wire, generators, batteries and motors, it will be possible to be very daring and to go the whole way.

Battery Labour

It seems a pity to have an unnecessarily large number of accessory drives on our already complicated engines. Since we can't do without generators (nobody has yet invented a navigation light which can be lit, or a wireless set which can be worked, off the hydraulic lines), we may as well try to do without hydraulic pumps. But not yet. Let us not go suddenly all-electric in the middle of a war; for one thing it will not be possible to turn all the fitters (or riggers? I can never remember whose job it is to deal with hydraulics) into A1 electricians immediately. For another, there are a lot of excellent and reliable factories turning out excellent and reliable hydraulic items, from pumps to tail-wheel jacks. And for a last thing, we must give the designers time and lots of practice in electricity, otherwise they may still try to save weight by operating the undercarriage off a flashlamp battery.

What about arranging for the auxiliaries to have their own battery power? Then the fitters and/or pilots can happily run down the battery while trying to start an over-doped engine, knowing that power is still available for other purposes. In a multi-engined machine a separate generator or generators could be used for each power supply. Not many people appear to have thought of that division of battery labour, which is obvious enough when weight is not such a tremendously important consideration. And it is *not* so important in modern machines, which have such a monumental reserve of power for take-off and such a high wing-loading that the odd few ounces per square foot will make very little difference.

Inertia Starters

Incidentally, there is a great deal to be said for the American system of using inertia starters. It is far easier on batteries than the ordinary starter motor, and it is nearly always possible to start an engine with a battery which is going steadily flatter and which would not be able to turn the engine over by "normal" means. With a flat (but not *too* flat) battery it merely takes longer to get the "flywheel" turning over sufficiently quickly before engaging the clutch. All the power needed to start an engine, with a normal starter, to be directly and immediately applied, whereas the necessary power can be "poured in" for a minute or more with the inertia system and "let out" all at once to give the engine a really smart turn. Over here we have the modern cartridge starter; this saves the battery, gives the engine the right sort of jerk to produce a start, and is, I believe, a good deal lighter than any other starting system.

Perhaps it is just as well that I've wandered from the original thesis. I am *not* very knowledgeable about electricity and I should probably have put my foot thoroughly into it—if I haven't actually done so. But since there are already such a large number of wires running about an aircraft, I see no reason why we shouldn't eventually go the whole way and have everything but the airscrews themselves electrically driven. Slower in operation, perhaps, for heavy movements such as those involved in raising an undercarriage, but there is no reason why electrical operation should be any less reliable.

"INDICATOR."

TO THE CRATERS OF THE MOON

Technicians appear to be agreed that theoretically it should be possible, provided certain experimental research is carried out, to fly to the moon in a rocket-propelled aircraft. Mr. F. Gordon-Crosby, in this picture specially drawn for *Flight*, shows his interpretation of the problem. He has permitted himself a certain amount of artist's licence, and in view of the pressures to be encountered one may doubt the feasibility of the large windows, for example.

WITHOUT PRIORITY

How One American Firm Built a "Plastic" Plane: The Langley Uses Few Priority Materials

A COUPLE of months ago, in our issue of October 30th, 1941, to be precise, we published photographs and a brief description of the new American Langley monoplane. More detailed information has now become available concerning the methods of construction used in building this interesting little experimental aircraft. It transpires that there is nothing remarkably new in the processes employed, but they have been applied with ingenuity by the designer of the machine, Mr. Martin Jensen, and the result appears promising.

The construction of the Langley, named after America's famous pioneer aircraft designer, Samuel Pierpont Langley, but not copied to the extent of calling the machine an "aerodrome," is based upon the so-called Vidal process. Mr. Vidal, it may be recollected, once upon a time, when he occupied a Government office, had the laudable but somewhat optimistic ambition of introducing the 1,000-dollar light plane. After returning to private life he became interested in plastics as applied to aircraft, and his process was tried experimentally on an Avro Anson in Canada. The Langley Aviation Corporation, of Port Washington, Long Island, made a very thorough survey of all existing methods of using plastics in aircraft construction, and came to the conclusion that the Vidal process was the most promising. It avoided almost entirely the use of priority materials and had other advantages.

The Langley monoplane is a four-seater, powered by two Franklin air-cooled engines of 65 h.p. each. It is of plastic-bonded plywood construction.

For the following notes on the building of the Langley monoplane we are indebted to our New York contemporary *Aviation*, in the November, 1941, issue of which there appears an article on the subject. We have space to reproduce the most outstanding points only.

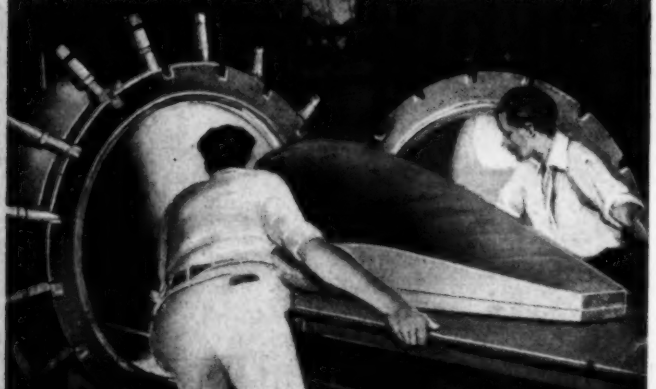
Very briefly explained, the system is to use thin veneers of Honduras mahogany, bent over moulds and cemented together under heat and pressure, to form the main components of the machine: fuselage, wing centre section, outer wing portions, stabilising and control surfaces. Honduras mahogany was used because it would withstand the fairly high moulding pressures without crushing. The veneer was all "flat-cut" mahogany, and the thickness varied from 1/64in. to ⅛in.

After "cooking." One-half of the fuselage of the Langley monoplane is removed from the mould. Afterwards the two halves are joined together by a phenol resin.

The resins employed were chiefly the vinyl thermoplastic and phenol thermosetting resins. For the benefit of the uninitiated it may be explained that the term thermoplastic is applied to resins which "flow" when sufficient heat is reached, set when the heat is reduced, and can be made to flow again when heat is applied. Thermosetting resins, on the other hand, will flow at a certain heat, but when they have once cooled down they will not flow again on a further application of heat. Vinyl, a thermoplastic resin, flows at about 200 deg. F. Vinyl resins were used in the Langley for the main structural components, and phenols for assembling, in place of nails or screws.

During the moulding process the veneer strips are laid on the mould, shaped if necessary for sharp curves, and stapled to the mould. The resin was then applied, the staples gradually removed, and a second layer laid over the first. Nowhere were fewer than three layers of veneer used, and where stresses were heavy multiple layers were applied. The finished component was then placed in a rubber bag, from which the air was exhausted before placing the component in an oven in which heat and "liquid pressure" (air, steam or water) were applied. After a period of some three hours—depending on the thickness of the veneer—the temperature was reduced, the component cooled by water, and finally removed from the mould.

The Langley monoplane is a four-seater powered by two Franklin air-cooled engines of 65 h.p. each. The tare weight is 1,410 lb. and the loaded weight 2,300 lb. Maximum speed is 142 m.p.h. and the machine cruises at 125 m.p.h. The range is 600 miles. A modified version fitted with two 90 h.p. engines is now being produced.



An engine nacelle of wood construction is placed in the autoclave, where it is formed by liquid pressure and heated until the vinyl resin flows. This happens at a temperature of about 200 deg. F.

TOO MANY DIALS

Is Not the Modern Aircraft Overburdened with Unnecessary Instruments? Their Weight an Important Aspect

By "KISMET"

HAVE you ever stopped to picture quietly to yourself the scene that is sometimes enacted as a stricken bomber tries vainly to limp home over the angry waters? The indomitable courage of the crew keeps them faithful right to the bitter end; with the R.A.F. that is a matter of course, and only a few disjointed words may come whispering out of the ether to tell the grim story.

The port engine, badly damaged over Hamburg, packed up long ago; the other motor, labouring and overstrained, beats dully on, while the aircraft sags lower and lower. Her crew feverishly jettison the oxygen bottles, ammunition, guns, log-books, personal effects, and any mortal thing that can be thrown over the side; sometimes even their parachutes. Then they wait, faithful unto death.

And as the vital minutes drag away, each minute a few miles nearer home and at the same time a few feet nearer the sea, there may stand betwixt the gallant crew and safety an odd hundredweight or two. Just that little bit of extra load saved would have kept them up until friendly soil lay beneath them once again; but there is nothing else left to drop. And so, after doing all that mortal man can ever hope to do in standing by their duty, one more crew "Failed to return."

But for the weight of instruments, they might have got home.

Evolution

When I learned to fly—and my first bungling efforts nearly broke two hearts—those of my instructor and myself—I used to sit in the back seat and feel a spasm of incredulity surge over me that any man could fly as my instructor flew, and I pondered his secret. In my extreme innocence I conceived that he must have some wonderful set of complicated instruments set there before him that enabled his eye to see a pictorial record of my foolish fumblings. One morning I peeped into the front cockpit, and do you know what I saw?

I saw a small piece of curved glass tube, with a bubble in the centre. That was all; the most simple and elementary form of cross-level yet devised. And that hero not only flew that monoplane trainer as I could never hope to fly it, but he trusted himself at times to my hamhandedness, corrected me, and finally passed me out with an "A."

How did he do it? I don't really know now, but I do know how he *didn't* do it. It was not by relying on a super collection of complex dials and gauges.

Some years after, I sat in the cockpit of a twin-engined bomber; one of the best, by the way, and a make that stood between this country and invasion. In front of, and around, me were exactly 47 dials or indicators. They required many hundreds of feet (or yards) of wire and tube to connect them up with their places of business. Some even needed liquid in bulk to feed them. Others had a kind of miniature framework of supports all to themselves, without which they would have rolled about under the seat.

I pondered. Was it essential, all this vast panorama of bits and pieces? This truly impressive collection of scientific odds and sundries? I supposed that it must be.

A few more years have now passed and I am not so sure—very far from sure, in fact. And, in any case, where is it to stop? What is to limit it? There must be a dividing line somewhere or other.

Who Controls?

The question can, and must, be extended. Is the pilot of a bomber, or fighter, there to fly it, or is he there to carry out the behests of a set of coldly indifferent instruments? Everybody appreciates the difference between the respective duties of bomber, fighter and trainer. An exact comparison is not fair because of the dissimilarity of functions that each is called upon to perform. Yet, where the basic exigencies of military aviation automatically call for the performance of many obligatory acts, such as shooting and evasive tactics, that are hardly taught on elementary trainers, these added responsibilities are not of themselves considered enough of a burden to the pilot. In addition, he is called upon to keep his eye on from 20 to 50 gauges. It certainly looks as though the gauges control the pilot, does it not?

The Fighter

Imagine two squadrons of single-seater combat planes, flown by men of equal skill, with one squadron standard in every way, and the other possessing aircraft in which the instruments were limited to the following: A.S.I., altimeter, compass, rev. counter, and nothing else.

Do those two squadrons, going into battle together, have equal chances, or not? Would a pilot with four instruments be under a severe handicap, or would he not?

Does a pilot make use of any instrument when he is actually in the thick of a fight? If an enemy machine shoots so well that an oil pipe is holed—well, it *is* holed, and having a gauge connected to it will not effect a repair. Neither is it likely to tell the pilot something that he does not already know. Then he comes in to land, and the under-carriage sticks solid. So what? He knows there is only one way to land, so he might as well get it over and hope for the best. Flaps? Well, a pilot ought to know whether his flaps are up or down without a gauge; and if they stick as well he still has to land.

What else is there? Many things, of course—oil, for example. Is it really essential to know the pressure, flow, ingoing temperature and outgoing temperature? The rev. counter will give ample warning of the engine's beginning to seize, and that is all there is to worry over. Petrol, oil and coolant should be "topped up" on the ground and then left alone.

The length of flying time is known by the ground control as from the moment each squadron goes up, and they should be recalled when fuel consumption makes such a move necessary. (They may of course, be recalled long before then for other reasons.) But the maximum duration of flight can hardly depend on fuel

TOO MANY DIALS

gauge readings by individual pilots when "Remote Control" has become such a fine art.

The Bomber

Here we must allow that for long-distance flying, prolonged periods of blind-flying, and so forth, extra instruments *are* needed. They must be regarded, within limits, as indispensable. But what are the reasonable limits?

From time to time one reads that certain instruments froze up solid on a trip to, let us say, Berlin. But that did not stop the bomber from getting there, and doing its job of work. Then on the way back home again what is the true position of the navigational requirements? What is the irreducible minimum complement of gauges and instruments absolutely essential to finding the home station, and landing thereat?

This question is so difficult to answer (and I am the first to admit it) that it may be necessary to consider the exact opposite, and so arrive at an answer by deduction. For example, can anyone prove that an analysis of the exhaust gases is, strictly speaking, indispensable to a returning bomber, perhaps badly shot about? Or that it really matters that the oil in the port engine is seven degrees hotter than the oil in the starboard power-plant? Or that the whole machine is nose-heavy?

Since the war started I have seen, handled, and tested many kinds of aircraft instruments, and I am frankly amazed at the extreme ingenuity of the designers; at the same time I am equally appalled that they consider it a constituent principle that half the stuff should be carried at all, let alone all of it. That great truism, "Simplicate and add more lightness" is in grave danger of being forgotten, and the day may dawn when an aircraft will fail to fly at all owing to the excessive weight of dials, gauges and what have you?

The Parting of the Ways

Where, then, is it all to end? In some of the largest of the planes in service with the R.A.F. there are so many instruments that the pilot is no longer expected to worry about the majority of them. They are housed in a miniature cell of which three walls may be said to be padded with dials. A flight engineer sits there watching them, and no doubt he can tell at a glance if an unauthorised fly has settled on an oxygen bottle. As bombers get larger and larger there may be several padded cells required in each one to accommodate the full panorama of these multitudinous excrescences.

Each and every plane will become a flying laboratory.

It appears, then, that we have two alternative lines along which future design can move. Either the weight of instruments carried will exceed the weight of bombs on a given machine, or the Powers-that-Be will come to recognise that pilots are prepared to take quite a lot on trust, especially when sitting behind engines by Rolls-Royce, Bristol, Napier, and one or two others.

I am reminded of a short story that has a moral in it. One day I drove to Brooklands in the family saloon; a very nice sedate car that mounted nine instruments on the facia board. Having arrived at the track I changed into overalls and slipped into the seat of a 180 m.p.h. single-seater racing job, product of a world-famed Italian factory, hand-built, and tuned to the last ounce. In front of me were three dials, and three only: rev. counter, oil pressure, water temperature!

THE WILL TO WIN

Sacrifice Demanded

A FEW hours before he set out to fly to Berlin, a sergeant navigator in a Wellington bomber squadron wrote a letter to his parents. It was his last letter to them before he was reported missing. They had expected that he would be given a temporary rest from operations, and when they learnt that he would first have to make some more flights he wrote: "If you knew the case as I do I'm sure you'd think as I do, that it can't be helped and make the best of it.

"It will be a chance in a very direct way to increase our war effort, and that is, after all, all that matters. When all is said and done, the main thing is to get the war over, not to quibble about it. I only hope the people in the workshops realise that as forcibly as we do. I am sure if they only realise what our war effort at this moment means to us, to this country, to our daily lives, for the rest of our time on this planet, there would be such a revolution in the attitude to this war that production, morale, the very will to win, would all soar up to unprecedented heights.

"It is everyone's job at the moment who can think to make those less fortunate realise that we are now at the critical stage of our history and nothing short of absolute sacrifice of everything to the one aim will be of the slightest use—and that taken to the point past endurance, where only the will hangs on: will to win . . .

"I'm afraid something has happened to me that I thought never could. I've got hopelessly service-minded and don't live for anything else much these days. The more you see of this racket the more wonderful you realise the majority of the men in it are. It gets you in the end.

"I'm happy now and very much at peace inside myself, which is a great thing. I can't explain it. It just is."

Within a few hours of writing the sergeant was detailed for an attack on Berlin. The aircraft did not return, but news has been received that he is safe and a prisoner.

F. I. BENNETT

THE British aviation world learned with sorrow of the death, on December 30th, of Mr. F. I. Bennett, a director and chief engineer of Hawker Aircraft, Ltd. Frederick Ibbotson Bennett was not one of those men whose good work ever became generally known. Of a modest—one might almost say shy—disposition, he shunned the limelight. To him the team was what mattered. He was quite content if his firm's products received recognition; for himself he sought no credit. Yet those who have had the good fortune to know him and his work realise how much the Hawker concern owes to Mr. Bennett's wide engineering knowledge.

With the passing of Mr. F. I. Bennett British aviation loses yet another of its unobtrusive but extraordinarily useful workers. The industry will be the poorer for his going, and his friends will miss sadly his soft-spoken advice and gentle humour. He was buried at Long Ditton Parish Church on January 2nd.

NEW-YEAR HONOURS

Many Scientists, Designers and Production Chiefs Receive Recognition of their Work : R.A.F. Awards Include Two Military Crosses, One Bar to the A.F.C., 61 A.F.C.s and 25 A.F.M.s

FROM the list of New Year Honours conferred by His Majesty the King we quote the following:—

BARONET

Craven, Cdr. Sir Charles Worthington, R.N. (retd.), Controller-Gen. Min. of Aircraft Production, chairman and managing director, Vickers Armstrongs, Ltd.

KNIGHTS BACHELOR

Fedden, Alfred H. R., Chief Engineer, Bristol Aeroplane Co., Ltd.; Hilton, Robert S., Deputy Chairman, United Steel Companies, Ltd., President, British Iron and Steel Federation; Jones, Prof. Bennett M., Professor of Aeronautical Engineering, Cambridge, for services to aircraft development; Mills, Percy H., Controller-Gen. of Machine Tools, Min. of Supply.

ORDER OF THE BATH

G.C.B.

Smith, Sir Frank E., Controller of Telecommunications Equipment, for services to Min. of Aircraft Production and Min. of Supply.

C.B.

Evans, C. G., Principal Assist. Sec., Air Min.; Stewart, C. J., Director-Gen. of Production of Engines and Aircraft Equipment, Min. of Aircraft Production.

ORDER OF ST. MICHAEL AND ST. GEORGE

K.C.M.G.

Self, Sir (Albert) Henry, Director-Gen., British Air Commission, Washington.

ORDER OF THE BRITISH EMPIRE

K.B.E.

Abraham, John B., Deputy Under-Secretary of State, Air Ministry; Rootes, William E., Chairman of the Supply Council, Min. of Supply.

B. Melvill Jones, C.B.E., A.F.C., F.R.S., Professor of Aeronautical Engineering, Cambridge University—*A Knight Bachelor.*

ORDER OF THE BRITISH EMPIRE

C.B.E.

Dobson, R. H., Managing Director, A. V. Roe and Co., Ltd., for services to aircraft production; Harley, H. H., Chairman and Joint Managing Director, Coventry Gauge and Tool Co., for services to the Admiralty; Anwyll-Passingnam, Col. A. M. O., Sec., T. A. and Air Force Assocn., County of Middlesex; Rowe, A. P., Supt. Telecommunication Experimental Establishment, Min. of Aircraft Production; Wolfenden, J. F., lately Director of Pre-Entry Training, Air Min., Headmaster of Uppingham.

CIVIL DIVISION

O.B.E.

Shute Leete, B. M. T., Civil Aviation Directorate, India.

M.B.E.

Dubash, Nawal K., Chief Pilot Instructor, Bombay Flying Club.

DISTINGUISHED SERVICE CROSS

Pattisson, Sub-Lt. (A) K. S., R.N.; Coates, Flt. Lt. G. F. L., R.A.F.V.R.

DISTINGUISHED SERVICE MEDAL

Willis, Ldg. Airmn. N.C.; Parker, Sgt. G. R. L., R.A.F.

CIVIL AWARDS

O.B.E. (CIVIL DIVISION)

Francis, H. R., Director of Photography, Min. of Information; MacDonald, G., Deputy Director of Armament Production, Min. of Aircraft Production; Maxwell, R. H., Regional Director, Brit. Overseas Airways Corporation, Near East H.Q., Cairo; Messenger, L. V., Capt. of Aircraft, N. Atlantic Ferry Service; Pollard, P. E., Principal Scientific Officer, Air Defence Research and Development Establishment, Min. of Supply; Reddell, A. E., Director, Vickers-Armstrongs, Ltd.;

Sir Charles Craven, Controller of the Ministry of Aircraft Production and chairman of Vickers—*A Baronet.*

A. H. R. Fedden, M.B.E., D.Sc., A.F.R.Ae.S., chief engineer, Bristol engine division—*A Knight Bachelor.*

Mr. W. E. Rootes, chairman of the Supply Council, Ministry of Supply—*K.B.E.*

NEW YEAR HONOURS

(Left) Air Marshal A. W. Tedder, Air Officer C.-in-C., Middle East—*K.C.B.*
(Above) R. H. Dobson, managing director A. V. Roe & Co., Ltd.—*C.B.E.*
(Right) P. E. G. Sayer, chief test pilot, Gloster Aircraft Co., Ltd.—*O.B.E.*

Sayer, P. E. G., Chief Test Pilot, Gloster Aircraft Co.; Taylor, J. A., Principal Education Officer, R.A.F.Educ. Service.

ORDER OF THE BRITISH EMPIRE
CIVIL AWARDS
M.B.E. (CIVIL DIVISION)

Broad, S., Traffic Officer, Cl. 1, British Overseas Airways Corpn.; Gower, Commandant P. M. de P., O.C. No. 5 Ferry Pool, A.T.A., British Overseas Airways Corpn.; Simmons, W. G., Staff Officer, Min. of Aircraft Production; Skelton, P. N., Senior assist., Grade 1, Air Min.; Stapleton, J. T., Technical Officer, Directorate of Technical Development, Min. of Aircraft Production.

BRITISH EMPIRE MEDAL
CIVIL DIVISION

Burns, A. E., foreman, Sir W. G. Armstrong Whitworth Aircraft, Ltd.; Davies, F., in charge of a meteorological station, Bomber Command, R.A.F.; Gardiner, J., Working Chargehand, Vickers-Armstrongs, Ltd.; Harden, H. J., Civilian Instr., Technical Training Command, R.A.F.; Harflett, T. S., Principal Foreman of Stores, Maintenance Unit, R.A.F.; Lawson, H. C., Senior Foreman, Short Brothers (Rochester and Bedford), Ltd.; Wheeler, C. F., Civilian Wireless Operator, Coastal Command, R.A.F.

THE ROYAL AIR FORCE

The following appointments and awards are announced:—

K.C.B. (MIL.)

Air Marshal A. W. Tedder, C.B.

C.B. (MIL.)

Air Vice-Marshals G. B. A. Baker, M.C.; W. A. McClauchry, D.S.O., M.C., D.F.C.; L. D. D. McKean, O.B.E.; C. E. H. Medhurst, O.B.E., M.C.; J. C. Slessor, D.S.O., M.C.; Act. Air Vice-Marshals L. N. Hollinghurst, O.B.E., D.F.C.; H. P. Lloyd, C.B.E., M.C., D.F.C.; Air Comdres. W. A. Coryton, M.V.C., D.F.C.; H. Leedham, O.B.E.; R. P. M. Whitham, O.B.E., M.C.; W. D. Bostock, O.B.E., R.A.A.F.

Air Vice-Marshal H. P. Lloyd, C.B.E., M.C., D.F.C.—*C.B.*

C.B.E. (MIL.)

Air Vice-Marshals J. E. A. Baldwin, C.B., D.S.O., O.B.E.; W. Tyrrell, D.S.O., M.C., M.B., B.Ch., D.P.H., K.H.S.; Act. Air Vice-Marshals G. G. Dawson; A. H. Orlebar, A.F.C.; G. C. Pirie, M.C., D.F.C.; D. F. Stevenson, D.S.O., O.B.E., M.C.; Air Comdres. R. S. Aitken, O.B.E., M.C., A.F.C.; W. B. Cushion, O.B.E.; P. Huskinson, M.C.; H. K. Thorold, D.S.C., D.F.C., A.F.C.; Act. Air Comdres W. Elliott, D.F.C.; G. Jones, D.F.C., R.A.A.F.; Grp. Capts. E. B. Addison, O.B.E.; G. R. Beamish; L. M. Iles, A.F.C.; W. E. G. Mann, D.F.C.; J. L. Robertson; J. Rylands; A. C. Sanderson, D.F.C.; S. P. Simpson, M.C.; J. R. W. Smyth-Piggott, D.S.O.

O.B.E. (MIL.)

Wing Cdrs. S. J. Bailey, M.B.E.; W. F. Beckwith; F. J. St. G. Braithwaite; J. T. Brown; B. A. Casey; W. J. Cleasby; T. N. Coslett; C. L. Dann; E. H. M. David (now Grp. Capt.); H. D. Fraser; C. W. Glass, R.A.F.V.R.; E. M. F. Grundy; T. L. E. B. Guinness, M.P., A.A.F.R.O.; H. Hipwood; J. W. C. More, D.F.C.; E. J. Palmer; F. A. Pearce; H. D. Spreckley; G. C. Tomlinson, D.F.C.; J. B. M. Wallis; Act. Wing Cdrs. H. T. Andrews, R.A.F.V.R.; E. R. E. Black; H. Dawes, M.B.E.; A. G. Jarvis, A.F.C., R.A.F.V.R.; W. K. Lemay, A.A.F.; L. S. Thompson, R.A.F.V.R.; R. W. Woodley; Sqn. Ldrs. W. J. Loughhead; G. P. Smith, R.A.F.V.R.; R. C. Sutcliffe, R.A.F.V.R.; H. McD. Walker, M.B., Ch.B., M.D., R.A.F.V.R.; Act. Sqn. Ldrs. J. Clift; A. O. Mase, R.A.F.V.R.; J. S. Stevenson, R.A.F.V.R.; Act. Grp. Capts. C. Eaton, A.F.C., R.A.A.F.; V. E. Hancock, R.A.A.F.; Wing Cdr. E. G. Knox-Knight, R.A.A.F.; Major M. C. P. Mostert, S.A.A.F.

M.B.E. (MIL.)

Flt. Lts. A. T. Boon (now Act. Sqn. Ldr.); L. W. Shepherdson, M.C., A.A.F.; H. Thompson (now Act. Sqn. Ldr.); O. R. Toyne (now Act. Sqn. Ldr.); Act Flt. Lts. A. W. Alberry (now Act. Sqn. Ldr.); C. F. Burgess, R.A.F.V.R.; N. C. Cordingly, R.A.F.V.R.; E. G. Couch; C. T. Davies; A. E.

Dobson, R.A.F.V.R.; E. Dodd; J. W Elder, R.A.F.V.R.; C. S. Hawley, R.A.F.V.R.; F. James, R.A.F.V.R.; A. T. Jones, M.M.; L. H. Lainson; C. E. Langston; A. E. Lowe; H. Lyons; J. B. McGinn; A. A. Maton; D. B. G. Miles, R.A.F.V.R.; H. K. Newton; A. Purdie; P. G. Richardson, R.A.F.V.R.; N. A. Smith; C. V. Stammers; W. H. C. Syzling; L. W. Tee; H. G. Vevers, R.A.F.V.R.; A. C. Ward; M. S. Whitehouse, R.A.F.V.R.; J. H. Woffindin (now Act. Sqn. Ldr.); F/O.s H. Barr; R. H. Davies, R.A.F.V.R.; E. C. Jones; H. S. H. Meech; Act. F/O.s R. H. Boulton; A. C. Davis, R.A.F.V.R.; H. A. W. Rettig; P/O.s S. J. Davies; K. B. Dring; W. R. Owen; A. H. R. Taylor, R.A.F.V.R.; W/O.s R. M. Cooling; S. H. Cox, R.A.F.V.R.; C. McK. Crabb; W. McL. Gray; F. R. J. Gunn; A. B. Haskell; T. Kent; A. Kenyon; T. R. Lawson; J. L. McKenzie; D. V. T. Richards; A. H. Ridley; C. E. Smith; T. W. Turnbull; A. G. Wallis; W. J. Waters; H. Wilson; Act. W/O.s J. Briggs; E. C. Juffs; W/O. J. G. de V. Vermeulen, S.A.A.F.; Act. F/O. M. M. Mortimer, W.A.A.F.; Assist. S/O. A. B. Morris, W.A.A.F.; Flt. Lts. E. F. Easterbrook, R.A.A.F.; G. H. Kelly, R.A.A.F.; F/O. C. G. Skinner, R.A.A.F.; W/O. G. W. Trott, R.N.Z.A.F.

R.R.C.

Matron Miss W. M. Coulthurst, O.B.E., Princess Mary's R.A.F.N.S.

M.C.

Act. Sqn. Ldr. M. P. Casano, R.A.F.O.; Flt. Lt. W. J. L. Stevenson, R.A.F.O.

Bar to A.F.C.

Act. Wing Cdr. A. E. Clouston, A.F.C.

A.F.C.

Grp. Capt. C. L. King, M.C., D.F.C.; Act. Grp. Capts. J. H Edwards Jones, D.F.C.; J. R. Hallings-Pott, D.S.O.; Wing Cdrs. N. de W. Boult; R. H. E. Emson; J. Fulton, D.F.C.; R.A.F.O.; N. B. Hallmark, D.F.C.; V. H. A. McBratney; G. E. Watt; Act. Wing Cdrs. D. D. Christie; K. W. Gough, A.A.F.; J. A. Greenshields, R.A.F.V.R.; T. C. Macdonald, M.D., Ch.B.; Sqn. Ldrs. D. K. Banks, R.A.F.O.; W. O. V. Bennett; W. H. Burbury; R. P. Garnons-Williams, R.A.F.O.; G. R. G. Henderson; D. H. Holmes; D. P. McKeown, R.A.F.O.; L. D. Mavor; F. S. Powley; R. W. Stewart; A. F. White; J. H. Williams, R.A.F.O.; Act. Sqn. Ldrs. J. Barraclough; S. B. Bintley, R.A.F.O.; R. D. Davis, R.A.F.O.; A. M. Jardine; E. M. H. Slade, R.A.F.V.R.; J. Adams, D.F.C., R.N.Z.A.F.; Flt. Lts. B. J. Apthorpe Webb, R.A.F.O.; H. J. Cundall; A. W. Horne; L. L. Jones, D.F.C.; M. T. Judd, R.A.F.V.R.; G. F. Phipps, R.A.F.V.R.; H. A. C. Stratton, R.A.F.O.; J. R. C. Young, R.A.F.O.; Act. Flt. Lts. C. E. Ashdown; J. M. Birkin, R.A.F.V.R.; D. M. Egan; J. E. Houlston; R. H. Morton; A. P. Walsh, D.F.C.; J. R. Watt; F/O.s G. C. Brunner; J. A. C. Talbot, R.A.F.V.R.; P/O.s A. H. Hemsley; F. A. Sandeman, R.A.F.V.R.; W/O.s E. Bell; G. E. Dawe; E. Folley; A. G. W. Gold; E. Mayne; Wing Cdr. E. D. Scott, R.A.A.F.; Sqn. Ldrs. G. S. Coleman, R.A.A.F.; R. H. Cox, R.A.A.F.; S. de B. Griffiths, R.A.A.F.; T. Primrose, R.A.A.F.; Flt. Lt. G. U. Allan, R.A.A.F.; Act. Sqn. Ldr. J. Adams, D.F.C., R.N.Z.A.F.

Acting Wing Commander A. E. Clouston, A.F.C., in his pre-war record-breaking *Comet*—*Bar to A.F.C.*

A.R.R.C.

Sen. Sister Miss N. A. Hampton, Princess Mary's R.A.F.N.S.

A.F.M.

Flt. Sgts. J. F. Bishop; E. Foster; L. Ollier; R. Pitt; F. McG. Reid, R.A.F.V.R.; R. G. B. Summers; C. Taylor, R.A.F.V.R.; A. P. Tilbury; F. J. Wilson; Sgts. J. G. Astbury, R.A.F.V.R. (now P/O.); R. Brown (now P/O.); D. A. D. Cather R.A.F.V.R.; R. B. Clark, R.A.F.V.R (now P/O.); A. R. Gersekowski; D. J. Mackey, R.A.F.V.R.; S. S. Payne; F. J. Ruoff; F. C. H. Taylor, R.A.F.V.R.; Flt. Sgts. J. R. Lavers, R.A.A.F.; R. W. Saunders, R.A.A.F.; Sgts. R. D. Clarke, R.A.A.F.; J. K. McCarthy, R.A.A.F.; J. F. Mason, R.A.A.F.; M. Kidson, R.N.Z.A.F.; D. P. Phillips, R.N.Z.A.F.

B.E.M. (MIL.)

Flt. Sgts. W. J. Ashbee; F. G. Atkins; R. C. H. F. Barrett (now W/O.); L. S. Bates; R. Bond; S. Carter (now W/O.); J. T. Collin; W. Davison; S. G. Eldridge; R. H. Epsley; A. Gosney (now W/O.); J. E. Grime; R. B. Hawtin; W. H. Lewis; A. S. A. Lines (now W/O.); F. J. Lowe, R.A.F.V.R.; D. B. Macfarlane; R. Markey; H. Melia; G. W. M. Merritt; E. A. Miller; T. J. Murphy; E. J. Pearce; D. C. Pointing; L. J. Samson; G. M. Sellers; W. G. Smith, A.A.F.; H. H. Tennent; I. W. Thomas; J. Thompson; M. E. Wheeler, R.A.F.V.R.; Act. Flt. Sgts. R. F. Burnham; J. Ellison; W. R. Killick; J. Ryding; D. Smith; C. W. Steer; Sgts. H. W. Adams; A. Harvey; E. C. Jones; E. Loscombe; J. M. Smith; A. V. Spiers; W. Twentyman; D. Wallace; L. N. J. Williams; Cpls. J. W. Bettles; J. Boardly; C. Boyd; D. D'Arcy; N. Gouldin; R. W. Mawer; W. H. E. Page, A.A.F.; J. P. Quinn, A.A.F.; M. Roberts; T. E. Sinclair; L. C. G. Elliott, A.A.F.; A/C.1 N. D. Loane, R.A.F.V.R.; A/C.1 C. V. Tucker; J. H. Westgate; L.A/C. A. Owen; A/C.1 L. C Worgan; Flt. Sgt. M. Shezall, W.A.A.F.; Cpls. P. D. L. Sidebotham, W.A.A.F.; H. M. Terry, W.A.A.F.

New Year Greetings

SIR ARCHIBALD SINCLAIR, the Air Minister, in a New Year's message to the R.A.F. and to the W.A.A.F., in all commands at home and abroad, said:—"In the hard fighting and hard training of the past year you have played your part to the full. You have carried the great responsibility entrusted to the R.A.F. with pride and devotion to high achievement. "I thank you all, and I know that you will discharge the tasks that lie ahead of 1942 with the same courage and enthusiasm as you have already shown so splendidly."

Air Chief Marshal Sir Charles Portal has sent another message to all R.A.F. units, which reads:—"Your achievements in the past twelve months have fully justified my pride and confidence in you. I am sure that all of you, and not least those who are still under training, will respond eagerly to every call that is made on your skill and courage in the coming year."

Canadian Lancasters

AN announcement made in Ottawa reports that a $33,000,000 contract with National Steel Car Co., Toronto, to manufacture Martin B-26 twin-engine Marauder bombers has been cancelled, and replaced by an order for Avro Lancasters. In addition to the National Steel Car Co., the plants of Associated Aircraft Co., at Toronto, and the Canadian Car and Foundry plant at Fort William, Ont., will work on the Lancaster bombers. In making the announcement regarding the cancellation, Mr. C. D. Howe, Minister of Munitions and Supply, stated that the B-26 is being redesigned in the United States, and that the British Government had asked the Canadian Government to make the Lancaster bombers. Tooling up for Lancaster production has started. The Avro Lancaster is a four-engined bomber with Merlin engines.

Nightingale I Comes to Grief

A YEAR ago the British Nurses' Air Ambulance Fund contributed the magnificent total of £8,000 for the purchase of ambulances and aircraft. With part of the money a Boulton Paul Defiant night fighter was bought and presented to the R.A.F. The machine was named, appropriately enough, Nightingale. It did good work, but one night towards the end of 1941 it ran into an electrical storm, which put the instruments out of order. The pilot ordered his gunner to bale out, while he stayed with the machine and tried to make a landing. He crashed and lost his life in the gallant attempt.

A new fund has now been opened for the purchase of another machine. It has been opened, as was the previous fund, by our associated journal *Nursing Mirror* with a donation of £100. £5,000 is aimed at, and it is confidently expected that this sum will be collected so that Nightingale II may continue the good work begun by the first machine.

AIRCRAFT SECTIONS

The Importance of Torsional as Well as Flexural Rigidity in Steel Alloys, Aluminium Alloys and Magnesium Alloys

By E. W. THOMAS, Ph.D., M.Sc., A.M.I.C.E., A.M.I.Struct.E.

IN early structural designs struts were envisaged as rigid members of robust proportions and fashioned to resist direct crushing. The advent of mild steel and standardisation of structural sections produced compound riveted stanchions in which the metal was distributed with a view to maximum flexural rigidity. In built-up welded sections the process was carried a stage farther, and further economy achieved in the distribution of the metal. With the development of aircraft sections the ratio of strength to weight became still more important, and a search began for high strength alloys resulting in lighter and thinner sections. It is this latter factor of thinness that has resulted in metal now being distributed to give torsional as well as flexural rigidity, as demonstrated in the corrugated sections of modern aircraft.

The need for the consideration of flexural and torsional rigidity, in addition to direct crushing, can be simply demonstrated thus :

Consider a long and narrow strip of metal supported at the ends with end loading applied axially. Such a long strut will deform in a typical " Euler " curve, the bending being resisted by the flexural rigidity of the section.

If the long strip is wide and the load still applied via the ends, wrinkling or twisting occurs, such deformation being resisted by the torsional rigidity of the section.

In the standard sections such as angle, tee and channel the outstanding leg or flange will behave similarly, but the liability to twist will be increased since one long edge of the " strip"' will be supported.

It is thus clear that any formula for the design of aircraft sections should incorporate flexural and torsional factors.

Ratio of Flexural and Torsional Rigidities

The importance of considering torsional rigidity is indicated in Fig. 1, where the ratio of flexural to torsional rigidity is plotted against an increasing value of breadth to thickness of the outstanding leg of a simple angle section.

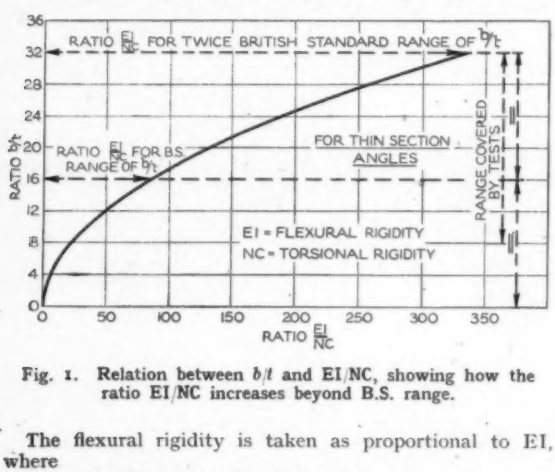


Fig. 1. Relation between b/t and EI/NC, showing how the ratio EI/NC increases beyond B.S. range.

The flexural rigidity is taken as proportional to EI, where

E is the Modulus of Elasticity and

I is the least moment of inertia ;

and the torsional rigidity is taken as proportional to NC, where N is the Modulus of Rigidity and

C is the torsional constant.

In Fig. 1, b/t represents the ratio of breadth to thickness of the outstanding leg.

In the British Standard range of equal angle sections the ratio of b/t does not exceed 16, and the ratio of EI/NC is 85. By taking b/t as 32, that is to say twice the range of the British Standard sections, the value of EI/NC is 335. The ratio of flexural to torsional rigidity has increased fourfold, thus exhibiting a marked deficiency in the torsional rigidity of the thinner sections.

Standard Sections

In the standard sections such as angle, channel and tee, the outstanding leg being thin will tend to deform under

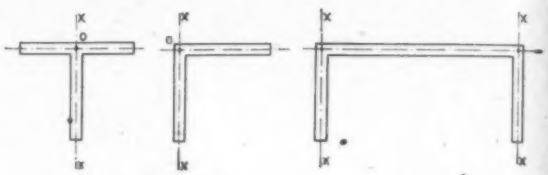


Fig. 2. Typical T, angle and channel sections.

end loading. Since such a leg is supported along one long edge, the deformation of the leg may be considered as

(*a*) bending about an axis of least moment of inertia, as XX in Fig. 2, and

(*b*) twisting about a centre of twist, as point O. The determination of the centre of twist will depend on the relative stiffness of the component rectangles of which the section may be considered formed.

Determination of Crippling Stress

Referring to Fig. 3, the general problem may be stated thus : Consider a strut of length " L," ends hinged, and let the area " a " be a small part of the cross section of the structural member. Then this typical longitudinal fibre will deform to a curve such as

$$y = \delta \cdot \sin \frac{\pi x}{L}$$

as shown in the elevation. The shortening in length of the member due to this flexure is

$$\tfrac{1}{2} \int_0^L \left(\frac{dy}{dx}\right)^2 . dx,$$

and if the end loading is " p " per unit area, the work done on this small longitudinal fibre is

$$dW = \tfrac{1}{2} p.a. \int_0^L \left(\frac{dy}{dx}\right)^2 . dx.$$

This work will be stored as flexural and torsional strain energies. The flexural strain energy is

$$dU = \frac{EI}{2} \int_0^L \left(\frac{d^2y}{dx^2}\right)^2 . dx,$$

the bending occurring about an axis as XX, see Fig. 2. The moment of inertia will be given by the expression $\frac{1}{12} . t^3 . dr$. The torsional strain energy is

$$dT = \frac{C}{2} \int_0^L \left(\frac{d\theta_1}{dx}\right)^2 . dx,$$

in which C is the torsional constant for the section, and θ_1 is the twist at any point x from the end. The value of $\frac{d\theta_1}{dx}$

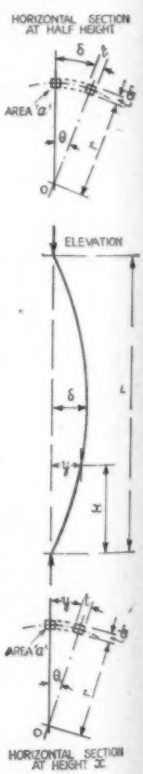


Fig. 3.

can be ascertained thus:

since $y = r\theta_1 = \delta . \sin \frac{\pi x}{L}$, then $\theta_1 = \frac{\delta}{r} \sin . \frac{\pi x}{L}$

and hence the value of $\frac{d\theta_1}{dx}$.

For a state of instability to occur the work done must exceed the sum of the flexural and torsional strain energies, and at the incidence of instability $dW = dU + dT$.

So far this only applies to a small longitudinal fibre, and for the whole section the condition may be rewritten as

$$\int dW = \int dU + \int dT$$

Referring now to the standard sections, failure will be determined by the behaviour of the outstanding thin leg. The torsional constant of such a thin rectangle may be taken as $\frac{1}{3}bt^3 . N$, where b is the breadth and t the thickness. Substituting in the above equation for the incidence of instability and evaluating the resulting integrals gives the following expression for the crippling stress

$$p = \frac{E.\pi^2.t^2}{12 . L^2} + N\frac{t^2}{b^2}$$

It will be noticed that this expression allows for the flexural ratio of length to thickness and the torsional ratio of breadth to thickness. This method of the use of strain energy is demonstrated by Professor S. Timoshenko in "Annales des Ponts et Chaussees," 1913.

Alloy Steels

For the steels and alloy steels used in producing rolled sections such as

ordinary structural steel,
high tensile structural steel, and
Staybrite steel,

and also the steels used for the thin sheet and strip for aircraft sections, such as

medium tensile alloy steels,
40–60 tons per sq. in. ultimate, and
high tensile alloy steels,
60–100 tons per sq. in. ultimate,

the value of the physical constants may be generalised as E = 13,400 tons per sq. in. and N = 5,150 tons per sq. in. (i.e. Poisson's Ratio of 0.3).

Substituting these values:

$$p = 11{,}000\frac{t^2}{L^2} + 5{,}150\frac{t^2}{b^2} \text{ tons per sq. in.}$$

It will be noticed that the effect of the first term diminishes with increasing values of the ratio L/t.

Fig. 4 gives values of crippling stress for values of b/t from 8 to 28, for a fixed value of L/t of 100.

The limiting values of b/t are conveniently summarised thus:

High tensile alloy steel, proof stress 80 tons per sq. in., limiting value of b/t is 8;
High tensile alloy steel, proof stress 60 tons per sq. in., limiting value of b/t is 10;
Medium tensile alloy steel, proof stress 40 tons per sq. in., limiting value of b/t is 12.

Compared with say mild steel, with a limiting value of b/t of 18, the limiting values of b/t for high tensile sheet and strip for aircraft are very much reduced.

Aluminium Alloys

The physical constants for aluminium alloy folded and extruded sections may be taken as

Modulus of Elasticity = 4,650 tons per sq. in.,
Modulus of Rigidity = 1,780 tons per sq. in.

The expression for crippling stress, using these values, becomes

$$p = 3{,}820\frac{t^2}{L^2} + 1{,}780\frac{t^2}{b^2} \text{ tons per sq. in.}$$

The values of crippling stress have been plotted on Fig. 5 for a fixed value of L/t of 100.

The limiting values of the breadth to thickness are summarised thus:

b/t of 8: extruded material, proof stress 26–28 tons per sq. in.
b/t of 9: aluminium coated alloy sheets, and extruded material, proof stress 21 tons per sq. in.
b/t of 10: extruded material, proof stress 18-19 tons per sq. in.
b/t of 12: extruded material and aluminium coated alloy sheets, proof stress 13-15 tons per sq. in.

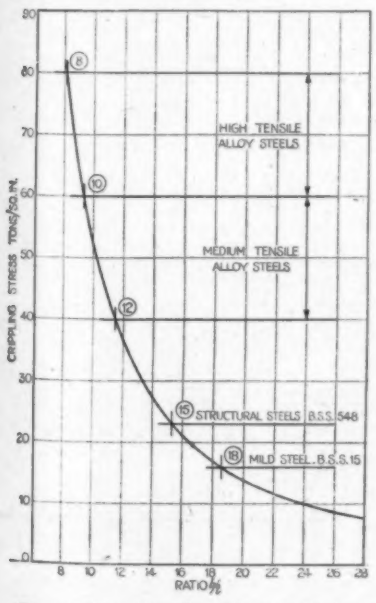
Magnesium Alloys

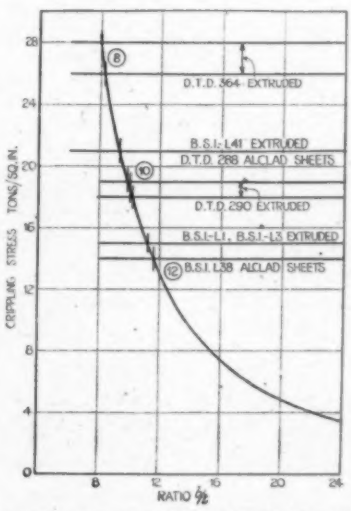
On account of the saving in weight that the magnesium rich alloys offer, it is interesting to derive the crippling stress equation for these alloys.

The Modulus of Elasticity is taken as 2,900 tons per sq. in. and the Modulus of Rigidity as 1,190 tons per sq. in.

The crippling stress

$$p = 2{,}400\frac{t^2}{L^2} + 1{,}190\frac{t^2}{b^2} \text{ tons per sq. in.}$$





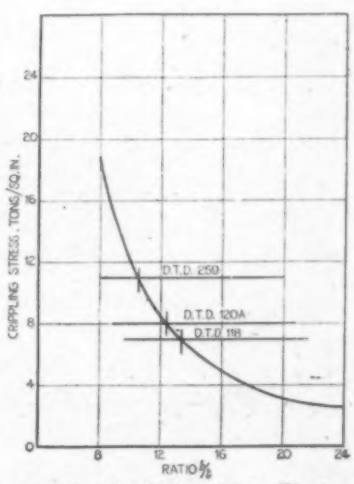


Fig. 4 (left): Limiting values of b/t for alloy steels. Fig. 5 (centre): Aluminium alloy extruded and folded sections. Fig. 6 (right): Magnesium alloy extruded and drawn sections, and sheets.

AIRCRAFT SECTIONS (CONTINUED)

The following is a summary of the available alloys:

Extruded material to DTD 259, proof stress 11 tons per sq. in., limiting value of b/t is 10;

Sheets suitable for welding to DTD 120A, proof stress 7-9 tons per sq. in., limiting value of b/t is 12;

Sheets suitable for welding to DTD 118, proof stress 6-8 tons per sq. in., limiting value of b/t is 13.

The limiting values are shown graphically in Fig. 6, the value of L/t being taken as 100.

Strength-Weight Comparison

In conclusion, it is informative to compare the strength weight ratios and the limiting b/t values for extruded, drawn or folded sections, and sheet and strip material.

Material, extruded, drawn, folded; sheet and strip	Proof Stress tons per sq. in.	Strength Weight Ratio	Limiting b/t Value
Alloy Steels	80	10.2	8
.. ..	60	7.7	10
.. ..	40	5.1	12
Aluminium Alloys ..	26/28	9.8	8
.. .. ..	21	7.6	9
.. .. ..	18/19	6.7	10
.. .. ..	13/15	5.0	12
Magnesium Alloys ..	11	6.0	10.5
.. .. ..	8	4.4	12
.. .. ..	7	3.8	13.5

The above figures will enable comparisons to be made. It is interesting to notice that a comparison of the high strength alloy steels and the aluminium alloys shows that the strength weight ratios and limiting breadth to thickness values run somewhat parallel. Thus an 80-ton steel has approximately the same strength weight ratio and limiting b/t value as the highest strength aluminium alloy.

Similarly, an 11-ton magnesium alloy will compare with an alloy steel of say 50 tons per sq. in. proof stress, and an aluminium alloy of say just below 18 tons per sq. in. proof stress. An exceedingly useful quality of the magnesium alloys is that on account of the relatively low proof stress, thicker sections are required and the liability to instability reduced. The increased weight entailed by the thicker section is offset by the lower specific gravity of the material.

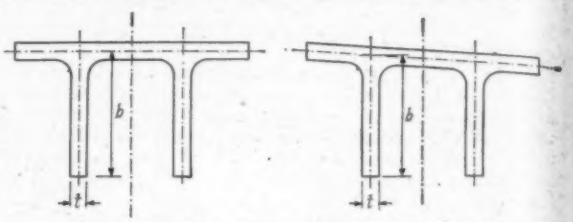


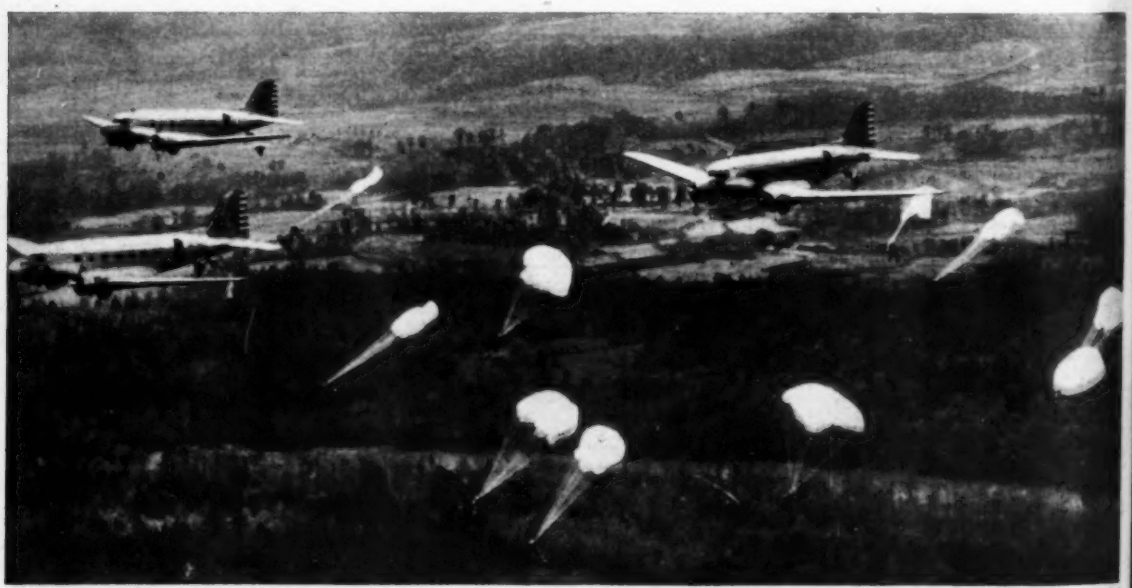
Fig. 7. Symmetrical and asymmetrical "pi"-sections.

Earlier in this paper reference was made to the search for high strength light alloys, and it will be seen that there is still scope for an ultra light alloy which would enable thicker sections to be used with increased elastic stability.

Application to Modern Aircraft Sections

The swift development of aircraft has created a vast number of sections, many of which require individual analysis to determine the load-carrying capacity. One very common and useful section to which the above method of analysis can be applied is the double tee section (sometimes called the "pi" section, on account of its resemblance to the Greek letter π). Fig. 7 gives two forms of this section.

Thus to prevent instability the ratio of b/t must not exceed the limiting values given above for the particular alloy in use. Other non-standard sections which can be so tested are the unequal channel, oblique tee, cruciform, zed, and what might be termed the multi-flat sections, i.e. any section in which thin outstanding legs or flanges occur.



RURAL FREE DELIVERY IN THE UNITED STATES: American paratroops in action. This time it was only a demonstration, but they have been well trained for "the real thing." The exit in the D.C.2s is far back and must result in a good deal of tail-heaviness with the troops concentrated near the door.

Correspondence

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers not necessarily for publication, must in all cases accompany letters.

NORTHROP TAILLESS AIRCRAFT

Wing-tip Design Modified

I WAS very interested to note that the Northrop tailless aircraft shown in a current news reel did not have wing tips with negative dihedral as shown in your issue of December 25, 1941.

It is quite possible that the negative dihedral tended to cause instability, and in any case normal ailerons would tend to act as rudders.

Or was I suffering from an optical illusion?

COLIN R. BARTY.

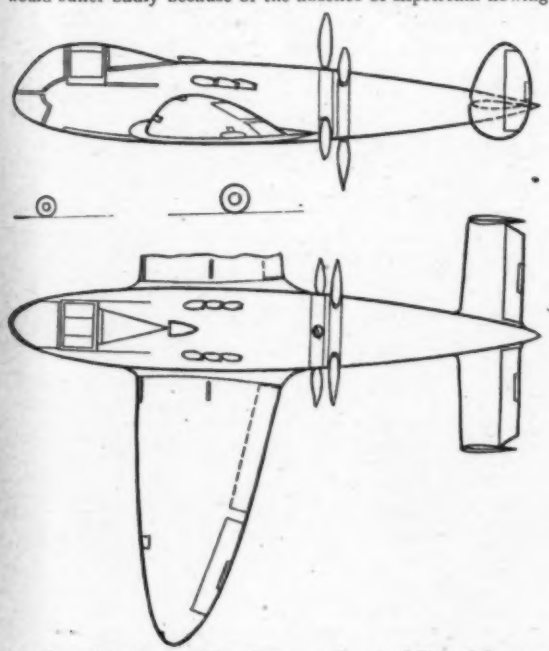
[Later photographs, one of which is published below, have since reached us showing a modified type without anhedral angle on the wing tips.—ED.]

FIGHTER DESIGN

Another "Pusher" Possibility

SOME years ago I had ideas of a fighter of similar layout to that described by Mr. P. Taylor. The drawings I made were almost identical, except that on my design the nose was rather more streamlined.

But I soon discovered plenty of disadvantages. The control would suffer badly because of the absence of slipstream flowing over the tail surfaces. Also there was the possibility of damage to the propellers when landing.



Feeling rather downhearted, I gave up the idea. Somehow it still haunted me. So I got down to it and evolved a new idea, the drawings of which I enclose.

The position of the propellers is not new—this idea was used on the Galaudet pusher in 1913—but it lends itself to greater efficiency than the "stern propeller."

Here are some of the advantages:—

(1) The same advantages as in Mr. P. Taylor's design, but with better control.

(2) Better weight distribution.

(3) Less chance of damaging the propellers when landing.

(4) Owing to the large propeller "hub," more blades could easily be added.

(5) The "hub" could be used as a reduction gear.

(6) No great length of shafting needed.

Disadvantages:—

(1) The problem of baling out.

(2) The expense of producing the propeller gear.

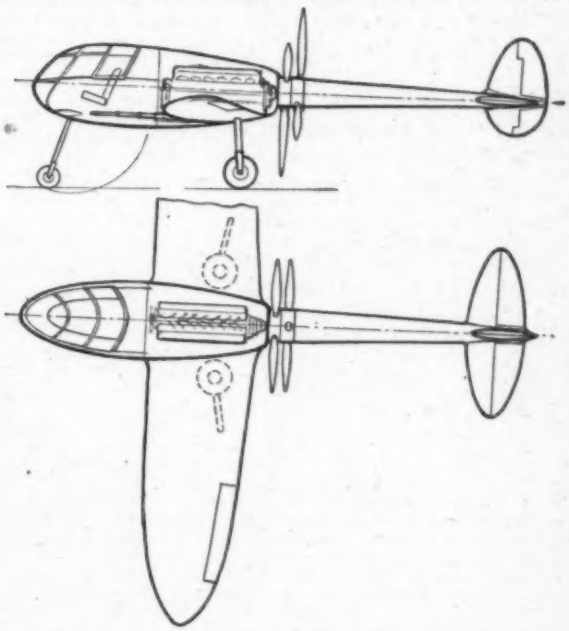
A machine of this type fitted with a barrel engine of 3,000 h.p. and with the pilot in the prone position is my idea of the ideal fighter.

R. CAMPBELL.

Yet Another Suggestion

MY suggestion for an improved form of fighter is that the tail-unit be carried on a thin boom passing through the prop. boss. In effect, this would be equivalent to having the prop. rotating around the centre of the fuselage.

As the average prop. seems to have a boss of about 18in. and the blade roots of non-aerofoil section for about another 6in., it should be possible, with correct design, to run a shaft of about 18in. diameter through the prop. boss in a similar way to the cannon in, say, the Airacobra. I doubt that cutting out the very non-effective centre of the prop. would cause much loss of thrust.



I should imagine that if the idea worked at all it would have many advantages over the conventional layout of the average fighter. For instance, the motor would be very near the C.G. as in the Airacobra, but without the complications of the shaft drive. It would also clear the nose of the machine for the cannon now coming into general use; fire concentration is better with grouped armament than spread along the wings.

This layout should give all the advantages of the twin fighter as to reloading, taking recoil and position near C.G.; without the complications of two engines, with their large weights out-

board of the machine's axis. I should imagine that this layout would give full scope to a large engine like the Sabre, and would suggest contraprops as there would be plenty of room for their gearing.

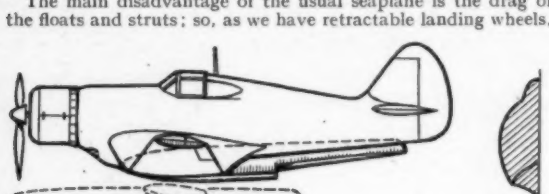
The undercarriage need not be any higher than usual if the two rear wheels of the tricycle are placed as near the plane of the prop. as possible. "FLT. LT."

CONVOY FIGHTERS

Why Not Retractable Floats ?

I HAVE been interested recently to read about the catapulting of fighters for the defence of convoys. I think that something might be done to develop a specialised fighter seaplane or possibly a small, fast flying boat. To my mind, the type that is required is a fast, well-armed seaplane.

The main disadvantage of the usual seaplane is the drag of the floats and struts; so, as we have retractable landing wheels,



why not a retractable float gear? This could be a main single float retracting backwards and upwards into a recess in the bottom of the fuselage. This fighter would also need retractable wing-tip floats, possibly of a type somewhat like those of the Catalina or, possibly, of the Do.26. A polyhedral similar to that of the Miles Master would mean that these floats would not have to have very long struts.

It has a twin-row radial engine for ease of maintenance, and follows conventional lines apart from the above-mentioned points. I trust that *Flight* will continue the good work it has done for so long. VERNON LACEY

(Apprentice of the De Havilland Aircraft Co., Ltd.).

TWO-ENGINED EFFICIENCY

Demonstrated by the C.W.20

THE all-round efficiency of the Curtiss-Wright St. Louis aircraft, described in the December 18th issue of *Flight*, is so far in advance of other four-engined aircraft of similar disposable load and the operating costs and complication are reduced to such a degree that one is very much inclined to the belief that two engines are better than four in an aircraft of medium size.

Maximum speed of the C.W.20 when mounting Cyclone 14-cyl. engines is now 262 m.p.h. at 13,000ft., which is appreciably faster than the Boeing four-engined "Stratoliner," although the take-off power of the latter aircraft is 1,000 h.p. more than the St. Louis. Again, the initial rate of climb of the C.W.20 is 1,500 ft./minute with a modest power-loading of 11.76 lb./b.h.p., as against 1,200 ft./min. for the "Stratoliner," which has a power loading of 10.23 lb./b.h.p.

Disposable load of the St. Louis—a transport version of the C.W.20—at an A.U.W. of 45,000 lb. is no less than 21,455 lb., or considerably more than double that of the Douglas D.C.3 with only 50 per cent. more power. Although the D.C.4 is more than 50 per cent. more powerful than the C.W.20, the maximum speed of the former is 265 m.p.h. at 16,900ft.; corrected to an altitude of 13,000ft., the D.C.4 is slower and has less disposable load despite its 5,200 h.p.

Quite apart from the lower drag of the twin-engined installation, the aerodynamic merit of the C.W 20 fuselage has been proved greater than that of any other streamlined body tested in the N.A.C.A. wind tunnel. It has been known for a long time that the normal-type windscreen with flat panels may add as much as 25 per cent. to the fuselage drag by breaking up the airflow over the latter. Viewed in plan elevation, it is obvious that the acceleration of the airstream over the body of the C.W.20 is much less violent than for the "Stratoliner."

Admittedly, the streamline form is a difficult one to mass produce; the Spitfire was no exception to this rule. But we can thank our lucky stars for the idealism of Mitchell that ignored manufacturing difficulties. Had it not been for this designer's idealism, we might have lost the Battle of Britain.

Whilst admitting that bomber fuselages are simpler to fabricate in their present non-aerodynamic form, the new Martin B-26 bomber is now being mass-produced with a beautifully formed fuselage that must add considerably to its performance. One cannot help wondering where we will be, after the war, on the score of efficiency if we continue to let power-driven gun turrets massacre our designs aerodynamically.

JOHN W. MORRISON.

CORRESPONDENCE

CAMERA CURIOSITY

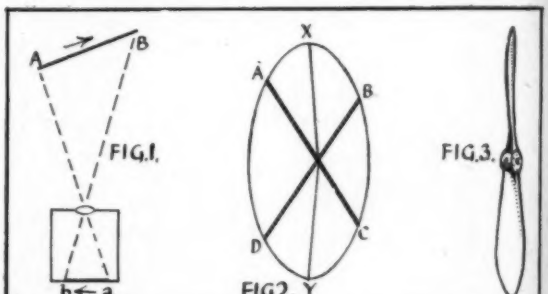
A Matter of Angular Velocity

"A PUZZLED SCHOOLBOY" asks why, in so many photographs of flights of similar aircraft, the airscrews appear in similar positions. To answer him fully would take several complete issues of *Flight*. As a painter of aircraft I have come in contact with this problem before and have studied many photographs as well as actual aircrews in an attempt to solve the problem of painting the illusion of airscrews in motion. I will briefly sketch the outline of my conclusions, but I must admit they are by no means final. I am, of course, more interested in the mental image rather than the photographic impression, but both are complementary to each other.

It has already been pointed out by Mr. Norman S. Aston that the average exposure is sufficiently long for the airscrew to complete at least one revolution; therefore, for the time being the limitations of exposure can be overlooked.

For an image to appear on the plate, that image must remain over any one point for at least a definite minimum period. This brings us straight to the point "angular velocity." Figure 1 depicts a camera, AB represents a motion from left to right, and a, b the image of that motion. If the speed of that motion from a to b is too great no image will appear. This is simple "angular velocity."

Consider the airscrew to be a stick; Figure 2 shows in perspective the disc made by this revolving stick and also the stick itself in two positions at right angles to itself. Thus the disc is cut into four equal segments—AB = BC = CD = DA.



In perspective the arc AB is much shorter than DA, yet the period of time from D to A and A to B is the same. Therefore, the "angular velocity" from D to A is greater than from A to B, and points X and Y are roughly the points of lowest "angular velocity" from this viewpoint (these points vary according to the viewpoint). It is obvious that whatever the speed of the airscrew the image will be most powerful in the region of line XY.

The images of a row of similar revolving sticks seen from nearly the same viewpoint will be very nearly the same, the error will be less than the untrained eye can see.

Now for the complications. Owing to the pitch of an airscrew, one blade seen in perspective will have a greater projected area than the other (Figure 3). Area has a great deal to do with "angular velocity" and the blade with the wide image will be magnified in intensity. The curious curved images of blades can be accounted for by this fact in conjunction with *local* "angular velocity."

The image of a three-bladed airscrew is more complicated but follows the rule; the blades appear at points of low "angular velocity," which causes great distortion. Whatever the complications, they will be common to all the airscrews in question and, therefore, if one is altered all will be.

Finally, if the exposure is less than one airscrew revolution of the slowest airscrew, then it would be a supernatural fluke if the images were similar, as all the airscrews would have to be perfectly synchronised. C. RUPERT MOORE,

A.R.C.A. (Lond.).

A Douglas SBD-1 dive-bomber landing on *U.S.S. Lexington*. Perforated flaps have been adopted to a greater extent in America than in this country. The wind shield for the landing control officer is of interest, as is also the wooden deck. Our decks are steel.

Royal Air Force and Fleet Air Arm News and Announcements

THE KING has been graciously pleased to approve the following awards in recognition of gallantry displayed in flying operations against the enemy:—

DISTINGUISHED SERVICE ORDER.

Act. Wing Cdr. T. O. FREEMAN, D.F.C., R.N.Z.A.F., No. 115 Squadron.—This officer has been engaged on active operations over a long period. Wing Cdr. Freeman has carried out sorties, involving attacks on Kiel, Berlin, and other important targets in Germany, a daylight raid on Brest, and an attack on Turin in Italy.

As commanding officer of the squadron he has set a splendid example by his leadership, enthusiasm and courage. In September, 1941, he led the squadron in an attack on Cologne and, in spite of fierce opposition, descended to a low level, flying over the area for over an hour searching for his objective, which he eventually bombed.

Later he led the squadron in a raid on Turin. In the face of heavy opposition he made a successful attack from low level. Wing Cdr. Freeman has spent many hours flying with young crews on operational sorties, and his personal example in the face of the enemy has proved a source of inspiration. While employed as navigation officer at station headquarters he continually carried out operations with the various units of the group, thus taking the opportunity to demonstrate, in a practical manner, the theory he was endeavouring to teach.

Act. Flt. Lt. R. R. BANKER, D.F.C., No. 50 Squadron.—This officer has performed brilliant work as captain of aircraft. Of recent months he has successfully bombed important targets on the Rhine and in the Mannheim, Karlsruhe and Frankfurt areas. His determination is such that, despite the most intense anti-aircraft fire and searchlight activity, he has descended to a low level after bombing so that his crew could machine-gun objectives on the ground.

Flt. Lt. Banker carefully plans all his raids and, during the operations, displays dogged determination to bring them to a successful conclusion.

DISTINGUISHED FLYING CROSS AND BAR.

Act. Flt. Lt. C. R. CALDWELL, R.A.A.F.—This officer, it is stated, has performed splendid work in the Middle East operations. He has at all times shown dogged determination and high devotion to duty which have proved an inspiration to his fellow-pilots. On one occasion, during a patrol, he was attacked by two Me. 109's. His aircraft was badly damaged, while he himself received wounds on his face, arms and legs. Nevertheless, he courageously returned to the attack and shot down one of the hostile aircraft.

A Free French pilot, whose name, for obvious reasons, may not be mentioned, who has 14 enemy aircraft to his credit. He has been awarded the D.F.C. and has nine palms to his *Croix de Guerre*.

The announcement of the award of the Bar states: This officer continues to take his toll of enemy aircraft. One day in December, 1941, Flt. Lt. Caldwell led his flight against a number of Junkers 87's, and during the combat he personally shot down five of the enemy aircraft, bringing his total victories to 12.

BAR TO DISTINGUISHED FLYING CROSS.

Act. Wing Cdr. W. S. GARDNER, D.F.C., No. 144 Squadron.—This officer has commanded the squadron for some time past and, by his splendid example both in the air and on the ground, has proved a great inspiration to all. His inspiring leadership has been reflected in the many successes achieved by his squadron.

F/O. R. WARREING, D.F.C., R.A.F.V.R., No. 106 Squadron.—This officer has carried out a number of operational sorties since being awarded the Distinguished Flying Cross. These missions include targets in heavily defended areas; he has also participated in daylight sorties wherein he has displayed superb skill. F/O. Wareing has always shown the greatest keenness and enthusiasm for operations.

Act. Grp. Capt. R. B. LEES, D.F.C.—Grp. Capt. Lees is a tireless, clear-sighted officer, possessing great energy. He has led the squadrons of his sector in sweeps over France, has taken part in all sweeps at long distances out to sea and has set a magnificent example to younger officers by his courage and resource. He has only one desire—to get to close grips with the enemy.

Sqn. Ldr. A. C. RAWLINSON D.F.C., R.A.A.F., No. 3. Squadron.—This officer continues to show the same admirable qualities which earned him the Distinguished Flying Cross in October, 1941. He has fostered great keenness and a fine fighting spirit amongst pilots of his squadron which, under his leadership, have taken every opportunity to destroy the enemy.

The squadron has destroyed over 100 hostile aircraft since the war in Libya began. One day in November 1941, Sqn. Ldr Rawlinson led an attack on a number of Messerschmitt 109's and fought them until after dusk. In the course of the engagement Sqn. Ldr. Rawlinson himself destroyed one and damaged two others of the enemy's aircraft. He has destroyed at least seven hostile aircraft.

Act. Flt. Lt. W. G. D. SMITH, D.F.C.—This

SERVICE AVIATION

A patrol of the new W.A.A.F. Service Policewomen who have been trained specially for their work.

officer, it is stated, has carried out 190 operational patrols during 1941. He has destroyed at least five enemy aircraft.

DISTINGUISHED FLYING CROSS.

Wing Cdr. H. J. KIRKPATRICK, No. 218 Squadron.—This officer has commanded the squadron for some time except for a period of a few weeks due to an injury received whilst trying to save members of his squadron when an aircraft crashed and a bomb exploded. He has displayed great coolness, leadership and courage during operational missions, many of which have been carried out at low altitudes; he has done much to instil confidence and fighting spirit in the young crews with whom he has flown. Wing Cdr. Kirkpatrick has also exhibited a high standard of initiative and resource when his station has been subjected to enemy air attack.

Wing Cmdr. G. A. WALKER, D.S.O., No. 50 Squadron.—This officer is not only a brilliant captain of aircraft but an outstanding squadron commander. His courage, determination and devotion to duty are exceptional, and throughout his operational flying he has always endeavoured to identify accurately his target, whatever the conditions, before releasing his bombs.

On one occasion the target area was almost completely obscured by cloud, but, descending through a break in them, he skilfully piloted his aircraft to his target. Climbing out of a balloon barrage into which he had flown, he bombed the target successfully. During the whole of the period, his aircraft was subjected to considerable anti-aircraft fire and searchlight activity. Wing Cdr. Walker has set a splendid example.

Act. Sqn. Ldr. J. FOSTER, R.A.F.V.R., No. 115 Squadron.—This officer has participated in numerous sorties, acting as captain of aircraft on many occasions. He has proved a most reliable captain and has always made every endeavour to reach and bomb his objective. His efficiency and leadership, combined with his excellent judgment, have inspired his crew and have also had a marked effect on the general efficiency of his flight. Throughout, Sqn. Ldr. Foster has displayed the greatest determination together with careful preparation so necessary in a captain of bomber aircraft.

Act. Sqn. Ldr. L. V. JAMES, No. 149 Squadron.—For some time this officer has acted as flight commander. He has participated in numerous operational sorties which have all been executed with great dash and vigour. On one occasion, in June, 1941, his aircraft was hit by shell-fire, but he flew it back to this country with the port engine emitting flames which were not extinguished until the aircraft had been safely landed. Sqn. Ldr. James has proved himself an excellent flight commander and leader.

Act. Sqn. Ldr. N. H. E. MESSERVY.—Sqn. Ldr. Messervy has carried out many operational flights often involving long sea crossings in bad weather. Throughout, he has shown excellent initiative and leadership.

Wing Cdr. M. J. LOUDON.—This officer has led the wing on operations throughout the present phase of the battle in Libya with great success; the squadrons concerned have probably destroyed and damaged more than 25 enemy aircraft. One day in November, 1941, the units under this officer's leadership engaged a force of 30 Junkers 87's, escorted by some 20 fighters, whose purpose was to dive-bomb our troops. During the engagement, eight Junkers 87's were destroyed, three probably destroyed, and a further nine damaged.

The successes achieved undoubtedly prevented serious losses to our ground forces and greatly raised the morale of our fighting forces. Much of the excellent work performed can be attributed to the courageous leadership of Wing Cdr. Loudon who has taken his own toll of enemy aircraft.

Lt. Col. L. A. WILMOT, S.A.A.F.—This officer has led the wing with great skill. In a recent attack on the landing ground at Sidi Rezegh much damage was inflicted on enemy aircraft on the ground, three being set on fire and many others damaged. Under his courageous leadership, many successes have been achieved both in air combat and in the machine-gunning of ground objectives in the face of intense opposing fire. Throughout, this officer has set a magnificent example. He has destroyed four hostile aircraft.

DISTINGUISHED FLYING MEDAL.

Sgt. A. HONIG, R.A.F.V.R., No. 14 Squadron.—On December 2nd, 1941, this airman was detailed to participate in an attack on concentrations of armed fighting vehicles and enemy transports. Despite adverse weather conditions, Sgt. Honig displayed the greatest determination to complete his task and finally carried out a most successful attack from a very low altitude. By his keenness and tenacity, this airman has been able to cause considerable damage and destruction to the enemy's armed fighting forces.

Flt. Sgt. H. A. ASKER, No. 226 Squadron.—During the squadron's activities in France, Flt. Sgt. Asker participated in many operational missions, a number of which were carried out in daylight. He has since participated in many daylight sorties and has shown navigational skill of a high order. His unfailing devotion to duty has set a splendid example.

Flt. Sgt. R. J. EDMONDS, No. 207 Squadron.—This airman has been employed as an air gunner on operational flying since the war began. Of recent months he has participated in many sorties involving attacks on important industrial targets and dockyard installations in Germany; also attacks on the enemy warships at Brest. Flt. Sgt. Edmonds has always displayed efficiency and enthusiasm in his work.

Flt. Sgt. F. FISHER, No. 138 Squadron.—This airman has been engaged as wireless operator-air gunner in operational flying practically since the war began. He has participated in operational sorties covering a wide range of enemy targets both in Germany and occupied territory.

On one occasion in June, 1941, the aircraft in which Flt. Sgt. Fisher was flying developed engine trouble, causing it to lose height from 11,000 to 3,000 feet. All loose equipment, ammunition, parachutes and guns were jettisoned. During these trying circumstances Flt. Sgt. Fisher coolly and skilfully continued to work his wireless set and succeeded in obtaining bearings which enabled his captain to fly the aircraft back to an airdrome in this country, where a safe landing was made with only one engine functioning. This airman has displayed courage and devotion to duty.

Flt. Sgt. J. E. HALLAM, No. 207 Squadron.—This airman has been engaged on operational flying in the role of air gunner since the war began. Since joining his present unit, Flt. Sgt. Hallam has carried out 21 sorties, including targets in Germany and attacks on the enemy battle cruisers *Gneisenau* and *Scharnhorst*. He has at all times shown great enthusiasm and efficiency and has set a fine example.

Flt. Sgt. E. R. W. WOOD, No. 138 Squadron.—With the exception of a period of four months this airman has been actively engaged on operations since the war began. Throughout, his work as wireless operator-air gunner has been of a high order. On one occasion Flt. Sgt. Wood performed excellent work when, following a heavy attack on Hamm, his aircraft was severely damaged by enemy shell fire. In the most trying circumstances he remained at his post and succeeded in obtaining bearings which enabled the pilot to fly the aircraft safely back to this country.

Sgt. R. B. BERNEY, R.N.Z.A.F., No. 115 Squadron.—This airman has proved himself to be a cool and courageous captain of aircraft. He has participated in attacks on enemy targets in Germany; he has also attacked Brest on nine occasions. Sgt. Berney has always made the greatest efforts to identify and attack his objective.

He displayed meritorious conduct on one occasion during an operational mission, when one of the unit's aircraft was forced to descend on to the sea some 40 miles from the enemy's coast. He successfully dropped food to the occupants of the dinghy, and then flew over the position for five hours until he lost sight of the dinghy owing to bad weather. Even then, Sgt. Berney continued his search, but lack of fuel eventually compelled him to return to base.

Sgt. E. J. BLAKEMORE, No. 9 Squadron.—This airman has participated in 31 bombing attacks, including many important targets in Germany and harbours in occupied France. One night in August, 1941, Sgt. Blakemore was the front gunner of an aircraft detailed to attack Mannheim. After the target area had been bombed Sgt. Blakemore's pilot, whilst taking evasive action to avoid anti-aircraft fire, lost control of the aircraft, which turned over on its back while at 12,000 feet.

The pilot regained control at 2,000 feet, but owing to a misunderstanding the navigator and first wireless operator had left the falling aircraft by parachute. Realising that the safe return of the aircraft would be largely dependent on wireless aid, especially as many of the navigation instruments had been lost, Sgt. Blakemore took the first operator's place, and, exercising great skill, coolness and perseverance, succeeded in getting in wireless touch with his base, thus obtaining bearings which enabled his pilot to fly the aircraft safely back to this country. His work instilled confidence in his comrades, and most certainly greatly assisted in their ultimate safety.

Air Chief Marshal Sir Philip Joubert, A.O.C.-in-C. Coastal Command, getting first-hand information from a flight lieutenant pilot who has just returned from an operational flight.

SERVICE AVIATION

Sgt. H. DICKINSON, No. 83 Squadron.—As a wireless operator-air gunner this airman has taken part in many attacks on enemy and enemy-occupied territory with great skill. On one occasion when his aircraft was forced to come down on the sea, this airman's efficiency and presence of mind in getting an accurate radio fix were responsible for enabling search parties to locate the dinghy with the minimum of delay. He has displayed great devotion to duty.

Roll of Honour

Air Ministry Casualty Communique, No. 100.

THE Air Ministry regret to announce the following casualties on various dates. The next-of-kin have been informed.

Royal Air Force

KILLED IN ACTION (WHILE FLYING IN OPERATIONS AGAINST THE ENEMY).—Sgt. E. Coombes; Sgt. T. G. F. Dixon; Sgt. F. A. M. Docker; Sgt. P. Fenn; Sgt. J. V. Hamilton; Sgt. G. H. Hellyer; Sgt. S. J. H. Jones; P/O. J. Kee; Sgt. R. J. Neville; Sgt. L. J. Pain; Sgt. N. J. Sharpe; Sgt. L. J. Travis; Flt. Sgt. R. C. Wood.

PREVIOUSLY REPORTED MISSING BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. K. V. Attew; Sgt. W. F. Hodson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—F/O. H. W. S. Adams; Sgt. D. W. Arnold; P/O. J. Barrett; P/O. N. G. Baxter; Sgt. G. H. Bishop; P/O. R. H. F. Blandy; W/O. C. Bond; F/O. H. F. D. Breese; Flt. Sgt. N. E. Byres; P/O. G. F. Chipperfield; Sgt. R. E. Cree; Act. Flt. Lt. A. A. M. Dawbarn; Flt. Sgt. L. S. Dilnutt, D.F.M.; Sgt. L. Dobinson; Sgt. J. G. Donnelly; Sgt. R. B. Edwards; Sgt. J. A. Faill; Sgt. A. Forsyth; F/O. D. G. Glennie; Sgt. F. Goodchild; P/O. R. L. Goord; P/O. R. J. Heavens; P/O. A. C. Holburn; Sgt. M. A. Hollinghead; Sgt. J. K. E. Horniman; Sgt. J. F. Horsham; P/O. J. Howard; P/O. H. P. G. Jones; P/O. S. M. Kolendorski; Sgt. J. Mc. A. Lowe; Sgt. T. F. McDevette; Sgt. D. McDougall; Sgt. A. V. McRae; F/O. I. N. W. Mackie; Sgt. F. G. Manning; Sgt. S. Miara; Flt. Sgt. W. C. P. Mitchell; A/C.2 H. V. Norton; F/O. W. Panton; Sgt. W. G. Price; Sgt J. L. Ransom; Sgt. G. B. Roberts; Sgt. P. G. Rose; Sgt. R. L. Sellars; Sgt. H. G. Sharp; Flt. Sgt. F. W. Sponder; P/O. J. A. V. Stockley; Sgt. C. P. Thomas; P/O. R. E. Tidswell; Sgt. D. C. S. Vane; Flt. Sgt. K. C. Walton; Sgt. A. Warcup; Sgt. H. Wood; A/C.1 J. F. Woodward.

WOUNDED OR INJURED IN ACTION.—Sgt. A. J. Ansell; Sqn. Ldr. D. E. Gillam, D.F.C., A.F.C.; Sgt. W. S. Humphreys; P/O. A. McInnes.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Sgt. W. A. Eaton.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. J. B Blackwood; Sgt. E. Crowe; P/O. F. L. Kidd; Sgt. C. Murphy; Act. Wing Cdr. D. R. Scott; Sgt. D. H. M. Stronach.

MISSING.—P/O. J. C. A. Allchin; Sgt. B. A. Beeby; Sgt. J. E. Chadwick; P/O. P. H. M. Clark; Sgt. W. C. Clarke; Sgt. H. Colling; Sgt. J. Davison; Sgt. S. J. Fenson; P/O. D. C. Firth; P/O. A. Franks; Sgt. T. E. Hedefine; Sgt. J. L. Holloway; Sgt. H. J. G. Jeffery; Sgt. W. King; Sgt. V. F. D. Kirk; P/O. C. D. Loughlin; Act. Sqn. Ldr. H. F. McCullagh; P/O. E. D. Main; Sgt. R. J. Morris; P/O. J. A. Nutt; Sgt. D. G. Pack; Sgt. R. A. Palmer; Sgt. W. J. Pearce; Sgt. F. A. Pegram; Sgt. R. E. Shears; Sgt. W. C. J. Spencer; P/O. D. Stein; P/O. G. E. Sweeney; Sgt. H. O'B. Talty; Sgt. C. D. Thomas; Sgt. T. H. Thorley; Sgt. J. J. Watson; Sgt. R. West.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE (WHILE ENGAGED ON NON-OPERATIONAL FLYING DUTIES OR ON THE GROUND THROUGH ENEMY ACTION).—Cpl. J. O. Kennedy.

KILLED ON ACTIVE SERVICE.—Flt. Sgt. L. H. Adams, D.F.M.; A/C.2 A. M. Bankier; Flt. Sgt. R. W. H. Baxter, D.F.M.; L.A/C. S. H. Bingham; Sgt. G. R. Bruce; L.A/C. E. E. Claridge; Sgt. J. M. Cohen; Sgt. P. G. Crosbie; Sgt. J. Dix; Sgt. W. M. Evans; Cpl. J. C. Fox; A/C.2 N. F. Green; Act. Flt. Lt. R. A. Henderson; Sgt. E. A. Lawrence; A/C.2 F. T. Malyon; Sgt. F. P. Miller; Sgt. D. F. Muir; Sgt. H. N. O'Shea; Cpl. E. E. Palmer; P/O. R. Scott-Worthington; Sgt. R. F. Sim; Sgt. P. M. Taylor; Act. Sqn. Ldr. M. J. Tully; A/C.2 G. S. Wakefield; P/O. R. A. L. White.

PREVIOUSLY REPORTED MISSING BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. D. Beaman; Sqn. Ldr. C. D. Hackett.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. K. C. Belton; Sgt. W. A. Bendy; P/O. J. Clapham; Sgt. W. Hunter; Sgt. N. R. MacMillan; Sgt. C. R. Nash.

WOUNDED OR INJURED ON ACTIVE SERVICE.—L.A/C. G. L. Barrie; Sgt. G. W. Bibby; Sgt. R. H. Coulter; A/C.2 W. H. Green; L.A/C. J. L. Higham; Cpl. S. Holmes; A/C.1 J. J. F. Jenkins; P/O. J. E. Johnston; A/C.2 L. Kerley; A/C.2 A. E. Lewington; Sgt. W. J. McFerran; A/C.1 A. W. J. Matthews; Act. Flt. Lt. R. A. Mosley; A/C.1 L. Norris; L.A/C. L. Powell; Sgt. H. A. Robinson; Sgt. C. S. Smith; Cpl. J. Wood.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. P. F. Brook; A/C.1 R. H. Holmes; L.A/C. G. J. Pritchard; L.A/C. H. Riley; P/O. I. A. Seggie; L.A/C. S. J. Stokes; P/O. D. C. Taylor; Sgt. G. A. Willats.

DIED ON ACTIVE SERVICE.—L.A/C. V. M. S. Austin; Cpl. J. R. A. Baker; A/C.2 H. E. Ball; A/C.1 D. W. Bannister; A/C.2 F. J. Beachus; Cpl. D. Blome-Jones; L.A/C. W. G. Chapman; Sgt. R. W. Chubb; L.A/C. E. T. Darby; L.A/C. P. A. Dyer; A/C.2 R. H. Edwards; Sgt. A. L. Ellis; L.A/C. L. A. Ford; A/C.2 A. R. Gibbons; Sgt. B. L. Jenkins; L.A/C. H. Jones; A/C.1 T. McCann; A/C.1 J. McLaughlin; A/C.1 W. H. McMillan; Flt. Sgt. E. Matthews; A/C.1 W. Morgan; A/C.2 J. E. Reynolds; Cpl. T. A. Rich; L.A/C. H. S. G. Sharp; Sgt. W. Shearsby; A/C.1 J. Silock; Cpl. J. H. Stephens; W/O. W. A. Stevens; A/C.1 A. Westmorland; A/C.2 G. W. Whitehead; A/C.2 J. P. Wright.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Sgt. J. H. Joy; Sgt. H. J. Phillips.

Amendment to Press Communique No. 94.

MISSING.—*For* Sgt. A. P. Vaisey *read* Sgt. J. R. M. Vaisey.

Women's Auxiliary Air Force

DIED ON ACTIVE SERVICE.—A/CW.2 D. Moore.

Royal Australian Air Force

KILLED IN ACTION.—Sgt. A. C. Bennett; F/O. P. R. Bothwell; Sgt. F. H. Lewis.

WOUNDED OR INJURED IN ACTION.—F/O. F. Fischer.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—P/O. J. A. Lopez.

MISSING.—Sgt. V. L. Brown.

KILLED ON ACTIVE SERVICE.—L.A/C. W. E. Clark; P/O. D. B. Elleray; Sgt. T. L. Leighton; Sgt. H. McMasters; P/O. D. T. Tucker.

DIED ON ACTIVE SERVICE.—P/O. H. M. Sutherland.

Royal Canadian Air Force

KILLED IN ACTION.—Sgt. D. Fleming; Sgt. F. A. Higgins; Sgt. H. B. Johnston.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. M. L. Burtis; Sgt. T. H. Rose.

WOUNDED OR INJURED IN ACTION.—Sgt. C. R. Golden; Sgt. H. Rivedal.

MISSING, BELIEVED KILLED IN ACTION.—P/O. J. A. Small; Sgt. I. Stein; Sgt. C. E. Wheeler; Sgt. H. R. Wilson.

MISSING.—P/O. K. R. E. Denkman; Sgt. J. J. Kelly; Sgt. J. G. Mackay; Sgt. F. G. Nadeau; Sgt. J. A. Steeves; Sgt. H. R. Vair; P/O. D. B. Van Buskirk.

KILLED ON ACTIVE SERVICE.—Sgt. L. J. Burke; P/O. G. M. Dunaway; Sgt. R. A. Mackay; P/O. J. R. Minard; Sgt. E. Ruppel.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. N. A. Ritchie.

Royal New Zealand Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. R. R. Passmore.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Sgt. I. H. Hunter.

KILLED ON ACTIVE SERVICE.—Sgt. R. E. Wilson.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. R. J. Kennedy.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—P/O. F. H. Anderson.

South African Air Force

KILLED IN ACTION.—Air Sgt. D. J. McIntosh; Air Sgt. J. D. Tonkin.

MISSING.—Air Sgt. P. A. Bleth; Air Sgt. G. N. Jonas; Lt. D. L. Lamont; 2/Lt. Reynepe.

KILLED ON ACTIVE SERVICE.—Air Sgt. F. H. Frolich; Air Sgt. E. F. Hubley; 2/Lt. L. R. Meintjes; Air Sgt. A. F. Robertson; 2/Lt. A. R. West.

Casualty Communique No. 101.

Royal Air Force

KILLED IN ACTION (WHILE FLYING IN OPERATIONS AGAINST THE ENEMY).—Sgt. R. Brown; Sgt. G. H. Cornish; Sgt. D. B. Heron; Sgt. D. G. Liveston; Sgt. R. B. Price; Sgt. E. Smith; Sgt. G. L. Swift.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. G. E. Cooper; F/O. A. D. S. Hicks; P/O. H. N. Hunt; Sgt. T. James; P/O. J. H. A. Linton; F/O. J. C. J. Lylian; Sgt. J. M. McL. MacDonald; F/O. J. C. E. Robinson; P/O. P. Singleton; L.A/C. B. W. T. Somers; Sgt. R. H. A. Warren; Sgt. D. A. Wilson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Act. Flt. Lt. J. O. Alexander; Sgt. J. Anderson; F/O. R. W. Ayres, D.F.C.; Sgt. H. E. Bailey; Act. Sqn. Ldr. R. R. Barker; Sgt. A. Barron; Sgt. J. A. Barron; Sgt. J. Beattie; Sgt. N. Berry; Flt. Sgt. J. L. Briggs; Sgt. R. A. Chatfield; Sgt. H. G. Chorlton; Sgt. A. P. Clifford-Reade; P/O. P. W. Comely; Wing

Pilots of the West Lancashire Squadron developing quick eyes and reactions by clay pigeon shooting. The squadron recently received commendation from Command H.Q. for their excellent night-fighting and bomber escort work.

SERVICE AVIATION

Cdr. P. B. Coote; Sgt. F. E. Davis; Sgt. E. Egar; Sgt. P. W. R. Emmett; Sgt. K. B. Fitzgerald; Sgt. A. Glover; Sgt. J. C. Goodwin; Sgt. A. J. Hardy; F/O. R. V. Herberj; Sgt. A. E. Hibbin; P/O. P. R. G. Howes; Sgt. V. Hughes; Sgt. J. Humphries; P/O. J. E. P. Jeff; Sgt. P. M. Kinsey, D.F.M.; Sgt. R. J. Leaper; Sgt. P. J. Lewis; Sgt. N. H. Meanwell; Sgt. C. H. R. Mercer; Sgt. P. A. Mills; P/O. E. L. E. Nicholson; P/O. L. W. Parfitt; Sgt. R. C. Plummer; Flt. Sgt. E. W. Rae; Sgt. D. G. Shayler; Sgt. D. C. Staples; Act. Flt. Lt. J. Stokes; P/O. R. W. Stolzle; Sgt. J. H. Storey; Sgt. L. Thorpe; P/O. H. U. H. Tripp; Sgt. A. N. Williams; P/O. R. J. W. Williams; Sgt. R. A. Williams; Act. Flt. Lt. P. Windram; Sgt. F. Wood; Sgt. W. N. Young.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Sgt. A. E. Burrows.

WOUNDED OR INJURED IN ACTION.—Sgt. T. R. Calder; Sgt. T. A. Dorey; Sgt. J. I. Fairbairn; P/O. R. B. Gilman; P/O. N. A. Ramsbottom.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. H. L. Hanson; Sgt. G. N. Parsons; Sgt. J. S. Poulton; Sgt. J. H. Woolman; Sgt. R. V. W. Walker.

MISSING.—L.A/C. J. K. Allan; Sgt. W. Bainbridge; Sgt. R. V. Bawden; Sgt. J. W. Bell; F/O. P. A. Bitmead; P/O. A. W. Black; Sgt. R. Boucher; Sgt. A. L. Boyde; Sgt. R. Bramhall; Sgt. D. C. Cameron; Sgt. F. Childs; Sgt. D. T. Clark; Sgt. K. D. Deadman; Sgt. R. F. C. Dean; Sgt. J. B. Drury; Sgt. H. W. Duffield; Sgt. R. Dundas; Sgt. G. A. Farmery; Sgt. B. Ferguson; Sgt. R. E. Glenny; F/O. R. H. Gordon, D.F.C.; Act. Sqn. Ldr. G. C. Halley; Sgt. R. N. Hanham; Sgt. D. L. Heald; Sgt. A. C. Homes; Sgt. J. M. Horsley; Sgt. R. H. Huckett; Sgt. A. G. C. Hunter; L.A/C. G. N. James; Sgt. V. G. Jee; Sgt. J. E. King; Sgt. J. O. M. Lobo; P/O. G. M. McCombe; P/O. C. McLean; Sgt. W. Massey; Sgt. J. Morris; Sgt. J. K. Moss; Sgt. R. Murphy; Sgt. R. North; Sgt. C. Northcott; Sgt. A. E. Nosworthy; Sgt. G. S. Nunn; Sgt. D. B. Pepper; Sgt. D. F. Pickerell; Sgt. R. W. Platten; Sgt. F. C. Reeve; Sgt. E. Rowlands; Sgt. G. R. Ruscoe; L.A/C. D. H. Saxton; Sgt F. S. Thomas; Sgt. G. T. Webb; P/O. K. E. Whalley.

KILLED ON ACTIVE SERVICE (WHILE ENGAGED ON NON-OPERATIONAL FLYING DUTIES OR ON THE GROUND THROUGH ENEMY ACTION).—L.A/C. R. C. Aburrow; Sgt. A. G. Arnold; Act. Sgt. H. Bellwood; Sgt. N. Borrows; Sgt. O. N. Brady; Sgt. C. M. A. B. Brett; Sgt. R. F. Callaby; Sgt. D. C. A. Carter; L.A/C. L. J. Dolling; L.A/C. D. Donahue; L.A/C. D. A. Drayton; Sgt. H. M. Exley; L.A/C. R. A. Gillman; L.A/C. W. Harris; L.A/C. J. Hartley; L.A/C. P. A. Hoare; L.A/C. H. Hodgkinson; Flt. Lt. K. C. Jackman; Sgt. C. Jakins; Sgt. E. H. Jacques; A/C.2 A. C. Nixon; Sgt. A. E. Norrish; Sgt. K. G. Parker; Cpl. W. A. Stapley; L.A/C. (Cadet) J. R. Stephens; P/O. P. P. Vernon; Sgt. C. M. Wesson; L.A/C. R. S. Wilson; P/O. M. C. Woodgate; Sgt. E. E. G. Woolley; P/O. K. F. Sleight.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—F/O. L. G. H. Kells; Flt. Lt. M. Kramer, D.F.C.; Sgt. G. A. McKenzie; Flt. Sgt. K. H. Squire.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW REPORTED KILLED ON ACTIVE SERVICE.—A/C.1 F. F. Addison; A/C.2 D. J. Page; Sgt. J. Perry.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. G. A. Adkin; Sgt. E. S. Bawden; Cpl. G. Chetland; Sgt. D. Cooper; P/O. M. G. Hilton; L.A/C. W. D. Holland; Sgt. A. H. Jackson; P/O. G. M. Sellar; P/O. J. G. Simpson; Sgt. G. Sweeting; L.A/C. J. O. Wilson; L.A/C. J. F. Winn.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. V. E. Overall; L.A/C. J. B. Price; P/O. J. Strathdee; L.A/C. G. H. Webb; L.A/C. R. T. Williams; Sgt. T. Woodward.

DIED ON ACTIVE SERVICE.—A/C.2 R. H. Bellamy; L.A/C. F. J. E. Blackstock; Cpl. R. Breeze; Flt. Lt. G. C. Challis; A/C.2 R. B. W. Chapman; A/C.2 K. G. Crofts; A/C.1 E. J. Curtis; Flt. Lt. F. D. Deeley; A/C.2 C. A. Drury; Sgt. R. C. England; L.A/C. B. Higgins; A/C.2 H. J. McL. Lawrence; A/C.2 G. J. Leech; L.A/C. T. Martin; L.A/C. F. R. Sollitt; A/C.2 J. O. Tebbitt; Cpl. J. Walker; W/O. T. Webb; A/C.1 W. Wilson.

PREVIOUSLY REPORTED MISSING, NOW REPORTED SAFE.—Sgt. F. B. Brandwood.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—L.A/C. J. Cassidy; Cpl. T. Cantwell; Sgt. B. H. Collins; A/C.2 P. Geiringer; A/C.1 F. Patterson; L.A/C. A. R. Richardson; A/C.2 F. H. Skan; L.A/C. R. Snowdon; A/C.1 M. B. Wade; A/C.1 J. Wallace; A/C.1 T. C. Yeomans.

Women's Auxiliary Air Force

DIED ON ACTIVE SERVICE.—Assist. S/O. J. A. Brown; A/CW.2 P. A. Burnham; A/CW.2 I. Chadburn; A/CW.2 D. Dare; A/CW.2 M. Fawcett; L.A/CW. M. M. Hall; A/CW.2 I. M. McDonald; A/CW.2 K. E. Pryor; A/CW.2 K. M. Threshie.

Royal Australian Air Force

KILLED IN ACTION.—Sgt. R. A. Bartsch; Sgt. E. C. R. Brooks.

WOUNDED OR INJURED IN ACTION.—Sgt. J. F. W. Ledbetter.

MISSING.—Sgt. A. Cook; Sgt. A. L. Cox; P/O. R. J. Furey; Sgt. C. A. J. Gilkeson; P/O. W. Goldman.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. K. H. Butler; Sgt. R. A. Glass; Sgt. C. G. Quirk.

DIED ON ACTIVE SERVICE.—A/C.1 J. G. Macfarlane.

Royal Canadian Air Force

KILLED IN ACTION.—Sgt. A. E. Shaw.

WOUNDED OR INJURED IN ACTION.—Sgt. M. R. Knisley.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. H. Macauley.

MISSING.—Sgt. T. E. Elliott; Sgt. F. Peever.

KILLED ON ACTIVE SERVICE.—Sgt. R. H. Beardall; Sgt. C. Desbaillets; Sgt. J. W. Ezzy; Sgt. H. A. Leopold; Sgt. W. M. McCausland.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—P/O. J. G. Dunlop.

Royal New Zealand Air Force

KILLED IN ACTION.—P/O. W. J. Allatt.

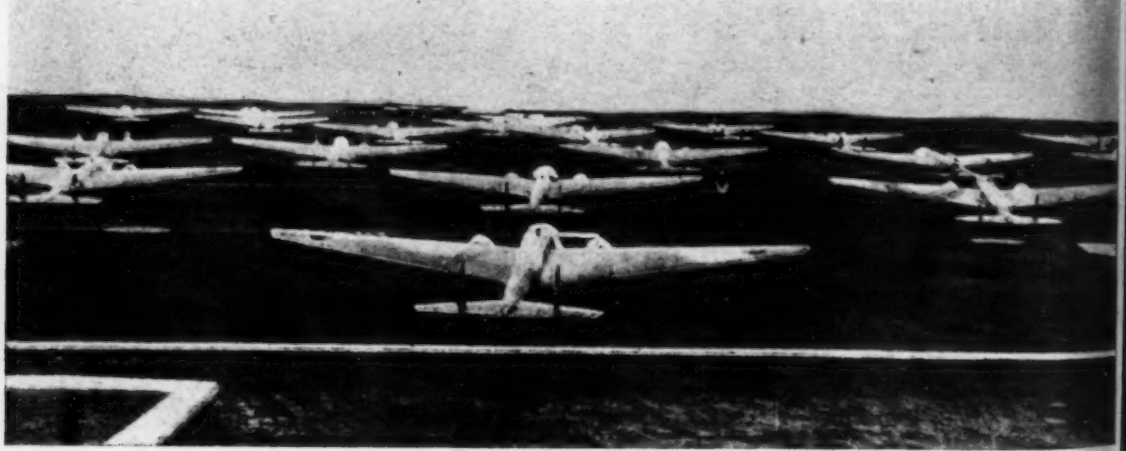
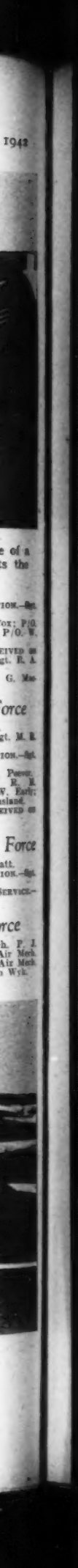
MISSING, BELIEVED KILLED IN ACTION.—Sgt. A. H. Harrison; Sgt. T. Y. Wyllie.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. R. T. Griffiths.

South African Air Force

DIED ON ACTIVE SERVICE.—Air Mech. P. J. Allen; Air Mech. S. M. F. Chaplin; Air Mech. B. J. E. Gelbrecht; Cpl. J. C. Middel; Air Mech. W. A. D. Thomson; Air Mech. D. S. Van Wyk.

SYNTHETIC NAVIGATIONAL INSTRUCTION : An instructor on one side of a dividing board gives his orders to the pupil by inter-com telephone and sets the instruments which represent the airspeed indicator and altimeter.



IN INDO-CHINA : Mitsubishi T96 twin-engined bombers.